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ABSTRACT

This guide is designed to provide teachers with materials they can use with young women to help them to attain higher levels of mathematics achievement and to encourage them to take as many math courses as possible in high school. During their early school years, students develop skills and attitudes toward learning that form the basis of future academic growth. This guide for elementary school teachers includes strategies, activities and resources that deal with five major topics. Part 1, "Attitudes and Math," includes materials on mathematics confidence, math aspirations and expectations, and attribution patterns. Part 2, "Math Relevance," contains materials related to interest in mathematics, making mathematics more relevant and useful, and positive role models for girls. Part 3, "The Learning Environment," contains materials on teacher-student interaction patterns, cooperative learning, problem solving, and independent thinking, intellectual risk taking, and creative problem solving. Other issues are collected in Part 4. Materials on computers, spatial visualization skills, and test-taking skills are included. Part 5 "Mathematics Promotion," includes materials on parent involvement, school counselors, and administrators and other teachers. Each topic in this guide begins with a discussion of research findings on the practices and/or attitudes that affect girls' math attitudes and performance. Strategies, activities, and resources that can be used to address each topic are described. Within each topic, activities for the primary grades are generally listed before those for the intermediate grades. An annotated resource list at the end of each chapter provides resources that contain strategies, activities, and ideas. (CW)

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Add-Ventures for Girls

Building Math Confidence

Elementary

Teacher's Guide

Research and Educational
Planning Center
College of Education
University of Nevada
Reno, Nevada

Women's Educational
Equity Act Program
United States Department
of Education

Add-Ventures for Girls: Building Math Confidence

Elementary Teacher's Guide

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Preface

The issue of girls and mathematics is important for all teachers. At the elementary level, girls often enjoy math and attain achievement levels equal to or higher than those of boys. However, by the time they reach high school, many bright girls become disinterested in mathematics, enroll in fewer advanced math classes, achieve lower math scores than boys on college placement tests, and are less likely to choose careers that are highly math-related. Mathematics is an important foundation for many rewarding occupations. In neglecting to develop their math skills, many girls are excluding themselves from a large number of potentially satisfying careers.

The reasons for high school girls' loss of interest and relatively lower achievement in math have been carefully studied by many researchers over the past ten years. No single cause has emerged. Instead, we find an interrelated set of attitudes, self-perceptions, and feelings, reinforced by society, parents, teachers, and peers that can combine to produce strong barriers toward girls excelling in math.

When girls enter elementary school, most of them enjoy math and do well in it. During the elementary grades, however, they begin to perceive mathematics as a subject more appropriate for boys and to lose confidence in their own mathematical abilities. It is particularly important that elementary teachers recognize the subtle and blatant messages that society gives to girls and take action to counteract these messages before girls drop out of math.

Although equitable mathematics instruction is very important, it is an area often neglected in teacher education. To fill this gap, many excellent supplementary publications on girls and math have been developed. This book describes the attitudes and the practices that cause girls to lose interest in math; it then provides strategies, activities, and resources that teachers can use to help girls overcome barriers and reach their full potential in mathematics. A second book has been prepared for junior high school math teachers.

To develop this book, we spent several months researching the subject of girls and math. We reviewed countless research studies and many resource books for parents and teachers. After delineating the problem and outlining the topics we wanted to cover in this guide, we invited local elementary, middle, and high school math teachers and administrators to brainstorm with us. These teachers and administrators discussed strategies, activities, and resources they had used in each of the selected topic areas. We incorporated their ideas, concepts from research materials, and our own thoughts into this guide. Two outstanding local elementary teachers, Darleen Azizi and Jackie Berrum, reviewed the book and added their comments and suggestions.

The final product represents the work of many persons. The authors wish to thank the members of our Advisory Committee: Kenneth Johns, Carol Olmstead, Jennifer Salls, Barbara Schlenker, Jeanne Reitz, Bob Howe, Diane Barone, Jackie Berrum, Shane Templeton, Randy McClanahan, Jesse McClanahan, Terri Walsh, and Elaine Enarson. We would also like to thank the teachers and administrators who contributed ideas: Terry Terras, Joe Elcano, Marian Marks, Margaret Mason, Marge Sill, Pat Haller, Al Babb, Yvonne Shaw, Joan Mueller, Dan Carter and Shirley Williams. Also, thanks to the members of the Research and Educational Planning Center office staff who prepared the manuscript: Sandra Walsh, Janet Oxborrow, Pat Downey, Ted Muller, Claudia Eaker, and Tina Wilkinson.

Introduction

> *In the past ten years there have been many attempts to explain sex differences in persistence and achievement in mathematics. Cases have been made for differences in brain development and lateralization, in spatial ability, in hormonal balance—even for the presence of a (male) math gene. Such research has a tendency to excuse and preserve the status quo. Indeed, it implies that the differences are natural and necessary, universal, and therefore just. I, on the other hand, have been content to be more modest: I simply visited schools where these sex differences in achievement were minimal or absent and looked around. The same hormones, the same brain lobes, the same maturation patterns were at work as prevail elsewhere. But the young women were learning mathematics—principally, so far as I could see, because they had been given good reason to think they could and should.*
>
> —Patricia Casserly, "Encouraging young women to persist and achieve in mathematics," p. 12

This book will help you give young women those "good reasons" to think they can and should learn mathematics. As an elementary teacher, you know that mathematics is an important subject. However, you may not be aware of how math acts as a "critical filter" when students enter postsecondary school. Without a sound advanced mathematics background, students are excluded from a large portion of college majors. A solid mathematics background is also crucial for most postsecondary vocational training programs and for most entry-level jobs. The purpose of this book is to help you prepare a foundation so that when they reach high school, students will want to take as many math courses as possible and will be able to achieve in mathematics.

During their early school years, students develop the skills and attitudes toward learning that form the basis of future academic growth. If students develop a negative learning pattern toward a subject, it is extremely difficult to change. We know that when girls reach adolescence, a number of factors may combine to produce strong internal (attitudinal) and external (societal) barriers to reaching their mathematics potential. Therefore, it is vitally important that elementary teachers do all they can to build girls' positive attitudes and skills in mathematics in the early years. This will help girls withstand later societal pressures, continue math studies, and feel free to select math-related careers.

This guide includes strategies, activities, and resources that deal with five major topics: Attitudes and Math, Math Relevance, the Learning Environment, Other Issues, and Mathematics Promotion. Within each of these major topic areas are several subtopics.

Each section of this guide begins with a discussion of research findings on the practices and/or attitudes that affect girls' math attitudes and performance. Strategies, activities, and resources that you can use to address each topic are described. Within each topic, activities for the primary grades are generally listed before those for the intermediate grades. An annotated resource list at the end of each chapter provides resources that contain valuable strategies, activities, and ideas.

Because many of the subtopics in the guide are interrelated, several of the strategies, activities, and resources are appropriate for more than one area. In those cases, the reader is referred to the appropriate section for additional information.

Most, but not all, of the activities in the book include math skill practice while covering the topics of concern. To use the guide, review it to see how the activities fit with what your students are currently learning. You may want to use the topic ideas, but modify the math portion of the activity to better fit your students' needs. The sections on attitudes and math relevancy are at the beginning of the book for two reasons. First, because negative and stereotypical attitudes about girls and math and lack of information about math usefulness and relevancy form the basis for many problems that surface later. And second, because we know that teachers usually devote little or no time to such topics. We encourage teachers to devise ways to spend more class time exploring and remediating negative attitudes and stereotypes and explaining why math is important; the time lost from math drill-and-practice will be more than returned when students develop positive attitudes and a high level of interest in math.

Another point that needs to be stressed is that although the activities and strategies suggested in this guide are particularly focused on providing equitable math instruction for girls, they can benefit all students. All of the suggestions are based on research findings, published resources, and practical ideas from math teachers. They represent sound educational practice and, when used as part of your mathematics curriculum, will provide a positive learning environment for both boys and girls. The book is based on the premise that we can encourage students' positive feelings as well as providing information about mathematical facts and processes. All students will benefit from this approach.

Part 1

Attitudes and Math

This section contains suggestions that will

1. help you build students' math confidence
2. raise students' aspirations and expectations
3. change detrimental attribution patterns
4. deal with sex-role stereotyping and stereotyping of mathematics as a "male" subject

Each of the following attitudes can deter a young woman from taking advanced math courses: having low self-confidence about her math abilities, having low expectations for success in math, attributing failure in math to lack of ability, and viewing math as "unfeminine." When these attitudinal factors are combined, they can form an almost impenetrable barrier to math for a young woman.

Many psychologists believe that changes in attitudes can follow, rather than precede, changes in behavior. The following section includes ways to encourage girls to exhibit positive behaviors toward mathematics.

Building Math Confidence

Researchers have consistently found that confidence in math is directly related to later math achievement and decisions to enroll in elective high school math courses. Girls' and boys' self-confidence in their mathematical abilities do not differ in the primary grades. However, by grade six, boys have more confidence, even though their math test scores and grades are not any higher than those of girls. This difference in confidence becomes more pronounced and more detrimental for girls as they reach high school. A sample of research findings on math confidence is listed below.

- At each grade level from six through eleven, boys are more confident of their math abilities. (Fennema and Sherman 1978)
- At all grade levels, girls are more likely to experience "math anxiety"—an extremely debilitating fear of mathematics. (Boswell and Katz 1980; Tobias and Weissbrod 1980)
- Even though boys performed no better than girls in math at age 13, boys were much more confident of their math abilities. (Lantz, cited in Chipman and Wilson 1985)
- Bright female students are the most likely of any student group to underestimate their chances of success in math. (Licht and Dweck 1983)
- Even female math graduate students who were achieving on a par with male students doubted their ability to complete their advanced degrees in mathematics. (Becker 1984)
- Students' confidence as math learners is strongly related to their perceptions of teacher encouragement. (Sherman, cited in Chipman and Wilson 1985)
- From elementary school to college age, girls consistently rate their intellectual abilities lower than do boys, despite the fact that girls generally get better grades and score higher on most aptitude tests. (Russo 1985)

Many research findings also indicate that girls have less confidence in their mathematical abilities, independent of any real difference in performance. Thus, it is essential that elementary teachers work to develop girls' confidence in their math abilities, so that as math becomes more difficult in junior high and high school, girls will continue to feel that they have the ability to learn it.

Skolnick et al. (1982) have suggested that teachers utilize tasks that offer success for each student, feature many approaches with many possible answers, and offer confidence-building opportunities for guessing, checking, and estimating. The strategies, activities, and resources described on the following pages are designed to help your students gain confidence in their math abilities.

Strategies

1. Build students' confidence by publicly and privately acknowledging their academic and intellectual accomplishments (not their effort); e.g., "Mary, you figured out that answer very well" or "Joanne, you're really learning to solve these problems. With a little more practice, you'll have no difficulty with decimals." Try to focus on the intellectual aspects of girls' performance rather than neatness, organizational skills, or "just trying."

2. Practice is extremely important in building confidence. Make sure that girls get enough practice so that they can feel confident with their math skills.

3. Another confidence-building method that encourages student involvement without individual risk is the use of slates. All the students can show you their answers at the same time, and you can determine how well you have done in teaching the concept.

4. Try to structure math learning activities so that all students will be able to achieve success at some level.

5. Incorporate some math problems that call for many approaches with several right answers. Stress the idea that, in most cases, there is more than one way to solve a problem.

6. Provide opportunities for estimating, guessing, and checking.

7. Recognize students' math achievement, and especially improvement, by creating a "Math Star" bulletin board.

8. Girls are often reluctant to recognize and acknowledge their own ability—especially in mathematics. Help them learn that it's okay to say, "I'm very good at math." It's not always easy for us to acknowledge our own abilities. If you are a female teacher, try setting an example for girls by saying something like, "I've always been good at math." If that statement is unrealistic, say, "I've always wanted to do well in math."

9. Create more opportunities for cooperative learning and minimize overt competition between classmates. Efforts to utilize groups where everyone must participate equally and will be given feedback collectively can be beneficial in building girls' math confidence. See the "Encouraging Cooperative Learning" section in this guide for further information.

10. Turn the tables in class, and let students take turns asking the teacher questions about math. This technique can generate some good discussion and promote the idea that "there's no such thing as a stupid question." In fact, questions become the learning environment norm with this practice.

11. Have children keep track of their own increases in computational speed and accuracy. Compare week-to-week results and reward students for bettering their performance records. In using this strategy, make sure students are competing with themselves, not with other students.

12. Use girls as peer tutors in math. Being asked to help others will definitely build the confidence of the tutor. Tutoring also helps both students gain increased understanding.

Activity

Guesses Galore

Objective

To provide students with an accepting environment in which they feel free to guess at math responses, minimizing the pressure for answer accuracy

Grade Level

Grades K–3

Time

10 minutes or longer

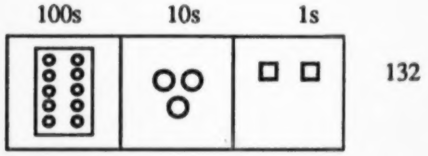
Materials

Chalkboard; jar of discrete items such as marbles, cookies, pennies, paper clips, etc.—size and number of items can vary. (For party days, use a related material, e.g., jar of candy corn for Halloween.)

Procedure

Ask students to guess how many items are in the jar. Encourage lots of guesses from each student and make sure all of the girls contribute their guesses. Depending on your class you may have to establish behavioral rules—no looking, etc.—during the guessing. Have students write down the guesses arranged from low to high or high to low to practice counting forward and counting back. Assign students to count the items and report the answer to the class. As they count, ask the students to count out the items into cups by 5s, 10s, or 2s, so that other counting can be practiced. Lay the objects out on a place value board, so the children can see a graphic representation of the number. For example, count 10 items into a cup; put 10 cups on the board.

Example



Variation

You can vary the things students guess about—e.g., how many petals on a flower, how many students have birthdays this month, how far is it from your town or city to some other city.

This guessing activity can be spread over several days. Let the children look at the container (use an adequate number of objects so they cannot be counted readily). Also change the container shape and size, but keep the quantity of items the same, and see if the children's estimations change. (Let the children see you change the items from one container to the next, so they understand that the number did not change.)

At Halloween, the number of seeds in a pumpkin can be used for guessing and checking. Also, students can compare a large pumpkin and a smaller pumpkin. Have the children decide which they believe will have more seeds, then count and report to the class.

Activity

Many Answers

Objective

To demonstrate to students that many problems have more than one "correct" answer; to allow all students to experience success and thus build confidence

Grade Level

Grades 1–6, depending on complexity

Time

15 minutes or longer

Materials

Slates, blank 5" x 8" response cards or pieces of paper, "Sample Questions" worksheet on the following page

Procedure

Use appropriate sample questions from the list on the following page, or construct your own. Have students work the problems. After students have shown their answers, determine how many different correct answers were given for each question, and discuss the idea of multiple approaches and correct answers with students. If students are responding on paper rather than slates, you may also want to let them determine how many children chose each correct answer. Make a sample bar graph of frequency of correct answers for each question.

Variations

1. Let students prepare or submit ideas for sample questions along with all the correct answers they can think of.
2. Give students a number, say "12," and see how many ways they can think of to add or multiply whole numbers or fractions to get this result.
3. The game of cribbage uses the principle of adding card values to reach 15. Teach your elementary students to play cribbage in its regular form, or vary the target number—use 12 or 23, for example.
4. Use real-life problems that could have many answers. For example, if Mary's allowance is $5, how could she spend (or save) it?

Worksheet

Sample Questions

What two numbers add up to 4? ______ + ______ = 4

What two numbers add up to 12? ______ + ______ = 12

What three numbers add up to 10? ______ + ______ + ______ = 10

What three numbers add up to 18? ______ + ______ + ______ = 18

What two numbers add up to 40? ______ + ______ = 40

What two numbers can be multiplied to get 6? ______ x ______ = 6

What two numbers can be multiplied to get 12? ______ x ______ = 12

What two numbers can be multiplied to get 100? ______ x ______ = 100

What two mixed numbers can be added to get 8? ______ + ______ = 8

What two mixed numbers can be added to get 13? ______ + ______ = 13

What two decimal numbers can be added to get 1? ______ + ______ = 1

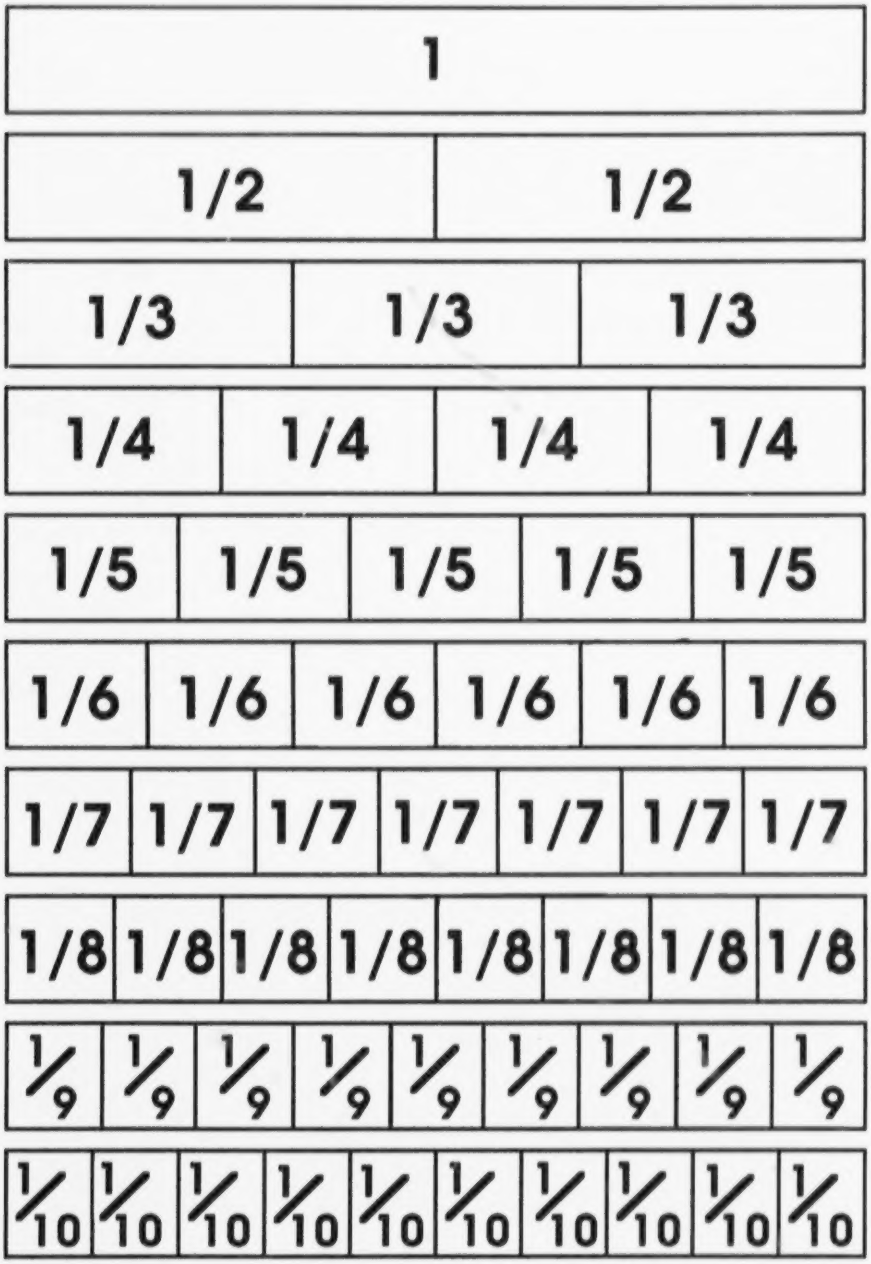
Activity

Fraction Grids

Objective	To build students' confidence in their ability to understand and use fractions by using manipulatives
Grade Level	Grades 1–6
Time	Variable
Materials	"Fraction Grids" on the following page (For grades 1–2, limit fractions to 1/2, 1/3, and 1/4.)
Procedure	Duplicate one copy of the fraction grids on the following page for each student. Grids may then be colored, laminated, and cut apart. They can be used in a variety of activities with fractions, and they are especially helpful for visualizing relationships between fractions. Ask a variety of questions that students can answer by looking at the grids. For example, which is larger, 1/3 or 2/5? How many eighths are in 1/4, and so on. After using the fraction grids, store them in individual coin envelopes.

Handout

Fraction Grids



Activity

More or Less Game

Objective

To build confidence by giving children practice recognizing relative sizes of numbers; to emphasize place value (see variation 5)

Grade Level

Grades 2–6 (You can vary the complexity, depending on game rules and how you number the cards.)

Time

5–15 minutes or longer per game

Materials

Deck of 50–100 numbered cards

Procedure

Construct the cards by cutting 3" x 5" cards in half and numbering each of the resulting 3" x 2 1/2" cards. The numbers do not have to be sequential. For example, you can use 10 two-digit numbers, 10 three-digit numbers, 10 four-digit numbers, and 10 five-digit numbers.

The game should be played in small groups of 3–6 students. Deal five cards to each student, and turn one card face up from the pack to start the game. Place the turned-up card in the center of the playing surface. Moving clockwise around the group, each student plays one of his or her cards by laying it face up to the right if it is *more* than the faced (played) card or to the left if it is *less* than the faced card. In the example below, card 51 was turned face up to start the game. The next player played 50 (less than 51) to the left. The next player played 73 (more than 51) to the right; 87 (more than 73) was then played to the right, and so forth.

A player who does not hold a playable card draws one from the pack and waits until her or his next turn to play. All players must monitor the game to be sure that no errors are made in placing the cards. If a player makes an error, the card must be placed back in his or her hand and another card drawn from the pack. Then the player must wait until his or her next turn to play a card. The object of the game is to play as many cards as possible and/or to be the person with the fewest total "points" left in his or her hands. The game ends when one player is out of cards or when no one else can play and all of the cards in the pack have been drawn. At this point, players with cards left in their hands must add the card values to determine the number of points they have accumulated.

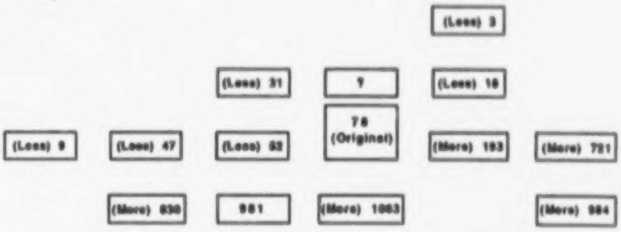
Less			Original (turned card)				More
19	42	50	51	73	87	125	1,080

Variations

1. To make the game very simple, use only numbers below 20 or 30 and play only left or right, i.e., *only more* or *only less*. For very young children, limit the number of cards to no more than 10, and include a template of the correct layout of those 10 cards so the children can self-check the game and reinforce the correct sequence.

2. To make the game more challenging, use larger numbers, deal more cards to each student, and/or allow students to play "up" (for less) and "down" (for more) from the already played cards as in Scrabble.

   Example



   In the example above, the space above the original "78" would be unplayable because the card played would have to be more than 31, and less than 78, but also less than 18! Similarly, the space below the 193 would be unplayable, but card 981 can be played because it is more than 830, more than 52, and less than 1003.

3. To emphasize cooperative learning, make the object of the game be that the group play as many cards as possible. Older students can discuss strategies for maximizing the number of cards played by the group.

4. In the lower grades, make correct reading of all numbers a task that gains the team a point. Numbers can also be identified as odd or even to earn a point for the team.

5. These cards can be used to practice place value. Divide children into two teams, and let each child randomly choose a card. The child must count out the correct number on each card using unifix cubes, beans, or sticks.

   Example *31* or *31*

unifix cubes

beans in portion cups

Activity

I Am the Greatest! Game

Objective

To give students practice reading large numbers and assist them in learning place value

Grade Level

Grades 4–6

Time

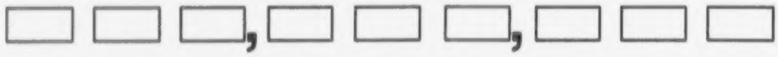
15 minutes per game

Materials

Chalkboard, numbered cards or tickets, small jar

Procedure

Cut out 20 small (1" or 2" square) cards, and number them 0 through 9. (You will have two of each number.) Draw nine large squares with two large commas on the board.



First, tell students that the object of the game is to create the largest number possible. Ask each student to draw the same squares on scratch paper. Put the numbered cards in the jar. Shake the jar to mix the numbers, draw out the first number, and announce it to the class. The students then write the number in one of their squares. Continue to draw and announce each number. Make sure students put their pencils down between numbers—no erasing or changing allowed. After you have drawn nine cards, all students should have constructed a nine-digit number.

Ask the students who has the greatest number. The student who thinks he or she has constructed the largest number reads it out loud—and has to read it correctly. Ask if any one has a larger number. Arrange the drawn numbers in order of magnitude to determine the largest possible nine-digit number that could have been constructed. Ask the students who came up with the greatest numbers to explain their strategies.

Variations

1. To make the game simpler and more appropriate for younger children use only three- or four-digit numbers.
2. This game can be excellent as a cooperative learning tool. Have small groups of students cut out squares or cards and number them. Each group tries to place their numbered cards or tiles in order to make the largest number. They then briefly discuss why they placed each card in the position they chose and work out a strategy for rearranging the numbers so that the largest number is obtained. Let small groups develop a strategy for playing the game when the actual numbers are unknown.

Note: Many teachers use Marcy Cook's tiling program (see resource list). Each student keeps a ziplock bag containing 10 one-inch square, light-colored ceramic tiles that are numbered 0–9 with a permanent marker. The tiles are great for games like this, as well as other active participation activities.

Activity

"Guesstimating" and Measuring

Objective To allow students to practice estimating and then checking their answers through measurement; to build confidence in estimating and measuring skills

Grade Level Grades 4–6 (For grades 1–3, see variation 2.)

Time 15–30 minutes

Materials Chalkboard, scratch paper, rulers, and other appropriate measuring instruments

Procedure Ask students, individually or in pairs, to estimate (or "guesstimate") a distance, weight, area, number of objects in a container, and so on (see examples below). Then, let students check their answers by actual measurement. Before the measurement process, discuss how students might find the answer.

It is important that you help students build estimating skills. Begin by working with small amounts or distances that they can actually count or measure, i.e., a small jar containing 15 crayons. The children may touch (handle) the jar.

As they progress, use larger numbers, distances, and so on, and provide reference points on which students can base their estimates. For example, "Here is a jar filled with marbles; write your estimate. Now, let me tell you that 10 marbles cover the bottom of the jar; do you want to change your estimate? Thirty marbles fill half the jar; do you want to adjust your estimate?" You can give the same type of reference points for distances, i.e., "It is 20 feet from the wall to this point."

Using this procedure, children will learn a method for determining their "guesses" or estimates, and not just respond with their "father's age" or a favorite number. For every guesstimate, help students develop a strategy for making a reasonable estimate.

Examples

How many feet wide is our classroom?

How far (in feet or yards) is it from our classroom to the cafeteria?

How long is a minute?

What is the area of our chalkboard?

How many boots are in the closet today (on a rainy or snowy day)?

Which of several flowers has more petals? How many petals does each have?

Which of these objects weighs more? What are two ways we could find the answer?

Which of these containers holds more water? What are some ways we could measure the amount of water each holds?

Use the suggestions above as ideas. Let students think up their own questions for the class.

Variations

1. Develop some guesstimating problems to use as take-home assignments—questions for which answers can be estimated at school and measured at home. For example, how many square feet are there in your kitchen? How far is it from your house to your neighbor's house?

2. For younger children, grades 1–2, this activity can be done using concrete objects for the measurement. For example, how many erasers long is your desk? How many new pencils will it take to go from the door to the wall? Next, compare two objects. How many more paper clips longer is this book than that book? (Subtract to find the answer.)

Resources

Burns, M. 1975. *The I hate mathematics book.* Boston: Little, Brown.

For those students who "seemingly" hate mathematics, this book provides many relevant activities to boost confidence and aspirations. Positive attitudes toward mathematics develop as students experiment with and investigate the uses of mathematics in solving everyday problems. Suitable only for upper elementary students.

Cook, M. *Math materials.* Catalog. Balboa Island, California.

These materials include tiling sets, task cards, and books designed to add variety to math. The materials emphasize problem solving and focus on active student involvement. Also included are several books on cooperative learning. The catalog is available from Marcy Cook, P. O. Box 5840, Balboa Island, CA 92662.

Downie, D.; Slesnick, T.; and Stenmark, J. K. 1981. *Math for girls and other problem solvers.* Berkeley: University of California, Math/Science Network.

The activities in this book encourage independent thinking and creativity in mathematics. Students and teachers are encouraged to think about problem solving in versatile ways and forms. Although this book was originally designed for females, the activities are appropriate and interesting to both boys and girls, ages 7–14.

Fennell, F., and Williams, D. 1986. *Ideas from the arithmetic teacher: Grades 4–6 intermediate school.* Reston, VA: National Council of Teachers of Mathematics.

This is a collection of classroom-tested activities from the journal *Arithmetic Teacher.* Perforated pages allow easy duplication of activities, which can be used for supplementing, extending, or reinforcing daily mathematics lessons in numeration, whole number computation, rational numbers, geometry, measurement, and problem solving. Objectives, grade levels, directions, and answers are given for each activity.

Holden, L. 1987. "Math: Even middle graders can learn with manipulatives." *Learning 87* 16, no. 3: 52–55.

Learning fractions can be frustrating. This article includes many ways that manipulatives can be used to help upper elementary students understand fractions and learn geometric concepts.

Jensen, R., and Spector, D. 1984. *Teaching mathematics to young children.* Englewood Cliffs, NJ: Prentice-Hall.

This teacher and parent resource suggests many activities that can be used to explore math concepts with young children. The suggested vehicles for math instruction—including manipulative and creative movements, art activities, and games—allow children to tackle new ideas while developing problem-solving skills. Chapters and activities are organized from concrete to abstract, so that young children may master mathematical concepts and gain confidence in learning.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. Ultimately, the purpose of the program is to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction. Materials are suitable for grades 4–12.

Skolnick, J.; Langbort, C.; and Day, L. 1982. *How to encourage girls in math and science: Strategies for parents and educators*. Palo Alto, CA: Dale Seymour Publications.

This excellent resource examines the effect of sex-role socialization on girls' math/science skills and confidence. It explains how attitudes, parenting and teaching practices, stereotypical play activities and books, peer pressure, and career and family expectations cause girls to question their abilities in math and science, and thus hinder their development in these areas.

In addition to the summary of the socialization process, the book contains a variety of compensatory educational strategies and activities that may be used to encourage females in mathematics. These particularly focus on increasing math confidence, spatial visualization skills, and problem solving. Both parents and educators can benefit from this book.

Souviney, R. J. 1981. *Solving problems kids care about*. Palo Alto, CA: Scott, Foresman.

Solving problems kids care about is divided into two parts. The first section includes notes and strategies for teaching mathematical problem solving. The second section contains thirty real-world problems that encourage divergent and logical thinking. Many of the problems have a range of acceptable solutions and multiple solution strategies, so students have the opportunity to be creative, independent thinkers. Activities are designed for elementary through junior high school students; teachers will enjoy them also.

Stenmark, J. K.; Thompson, V.; and Cossey, R. 1986. *Family math*. Berkeley: University of California, Lawrence Hall of Science.

If mathematics promotion is a goal of your teaching, *Family math* activities will help you introduce parents and children to ideas that improve their math skills and help them gain an appreciation for math. Hands-on mathematical experiences provide families an opportunity to develop problem-solving skills by using the following strategies: looking for patterns, drawing pictures, working backwards, working cooperatively with a partner, and eliminating possibilities. Spatial relationships (geometry), estimation, data interpretation (probability and statistics), and mathematical reasoning are the mathematical concepts learned from *Family math*. Materials suitable for ages 5–18.

Raising Math Aspirations and Expectations

Students' educational aspirations, or goals, are highly correlated to mathematics achievement. Generally, girls' aspirations for future math education are lower than those of boys; their expectations for success in math are also lower. In many cases these aspirations and expectations are learned from and reinforced by parents and teachers.

- Although during the early elementary school years, boys' arithmetic scores do not exceed those of girls, boys develop higher expectations for their performance than do girls. (Russo 1985)
- As compared to girls, boys in grades five through twelve had higher expectancies for success in their current and future math courses. (Wigfield 1984)
- Parents have lower expectations for girls' than for boys' math achievement (Fox 1977); teachers expect less of female students in math. (Cartledge 1984)
- In classrooms where bright girls had lower expectations for mathematics success, they received less praise and instruction from teachers. (Eccles [Parsons] et al. 1985)
- Parents consider math more difficult for girls than for boys, and they believe that girls have to work harder than boys to do well in math courses. (Eccles [Parsons] et al., cited in Stage et al. 1985)
- Parents chose more selective colleges for their sons than for their daughters, even though both groups of students were extremely high math achievers. (Franklin and Wong 1987)

Even when girls are achieving on a par with boys, they have lower expectations for success in math, and they plan to take fewer advanced math courses. We need to counter these attitudes by helping girls raise their expectations and aspirations. The strategies, activities, and resources described in this section are designed to do just that. We also need to work to change parents' attitudes. Some ideas for working with parents can be found in the "Mathematics Promotion" section of this guide.

Strategies

1. As a teacher, you help students set their aspirations for education and careers. Much depends on how students perceive your (and their parents') expectations for them. It is important that you hold high (but not unrealistically high) expectations for students, and that you encourage them to aim as high as they want when considering their future education and/or occupations.

2. To raise career aspirations, children must be exposed to information about careers. Use the activities and strategies in the "Math Relevance" section of this guide to help students learn about possible careers.

3. Because children's aspirations are so closely related to their parents' expectations for them, it is very important that you help parents raise their expectations. Use some of the "Tips for Parents of Girls" in the "Mathematics Promotion" section to get this message across.

4. Let students set their own expectations for grades by using the goal-setting sheets described in the "Learning Environment" section of this guide.

5. It is widely recognized that children enjoy the discovery provided by science study, but few teachers use science as a way of raising students' career aspirations. Point out that scientists are detectives who continually explore the possibilities of our world's connectedness. This makes students consider these careers exciting. Furthermore, make them aware of career opportunities via ample discussion of biologists, chemists, geologists, doctors, and engineers. Allow them to ask questions and speculate about each job's activities to expand their horizons and encourage them to consider other choices for "what they want to be when they grow up." Using the resource materials in the "Math Relevance" section, you can easily relate in-class math study to the science careers mentioned above. Girls whose interest appetites are whetted will benefit from knowing the usefulness of their math assignments.

6. The strategies and activities listed in the subsection on role models can raise educational and career aspirations for girls. The supplementary materials on women in careers helps girls become aware of women who possess high aspirations.

7. Teachers can provide direct recognition and invaluable support to students via private comments relating careers to students' abilities. Unless girls know their teachers have faith in their individual success, they will not be inclined to pursue highly competitive technical careers. Don't overlook other opportunities to link student success in a concept area to its usefulness in the real world.

Activity

Describe This Job

Objective

To provide a model for visualization of career choices; to elevate girls' career aspirations

Grade Level

Grades 2–6

Time

30–40 minutes

Materials

Used copies of popular magazines

Procedure

Sort through magazines such as *Forbes, Money, Newsweek, Vogue,* or *Working Woman* to locate pictures of women and men employed or engaged in comparable technical/professional positions, for example, women with hard hats, in suits, with briefcases, or in lab coats.

Glue the pictures to a tagboard and place them on the chalkboard, or pass each around the room. Allow the students to name each person. Ask students to describe the job each person holds in detail, for example:

a. Where does Jennifer (James) Barnes work?

b. What kind of math does she (he) use at work?

c. Does she (he) work alone or with other people?

d. How can you tell she's (he's) a smart woman (man)?

e. How big is her (his) family?

f. What does she (he) like to do for fun?

This may also form the framework for a writing activity, which students can share with the rest of the class. Ask students to add a brief description of how they would perform Jennifer's (James's) job, and submit the written assignment. Respond to *all* students' math and career aspirations with a very positive note of encouragement, but pay particular attention to the girls' aspirations.

Variation

In a related activity, students can imagine that they are the people in the pictures. Have them describe what they would do and how they would act. Or, students can select the picture that best describes their future, and then describe the person, the job, etc.

Activity

I Can Be Anything—What Will I Be?

Objective

To encourage students to think about their futures; to promote an environment in which daydreaming about the future is encouraged

Grade Level

Grades 4–6 (see variation for grades 1–3)

Time

Two 30-minute segments

Materials

Paper and pencils

Procedure

Handout the following passage to students, and give them time to read it carefully. Ask students to respond in writing to their specific daydream.

> You are an adult now. Think about what your life is like. Think about where you live. What does your house look like? What do you like to do for fun? What kind of job do you have?
>
> Pretend it is a typical work day for you. What clothes do you have on? Where do you work? What is your workplace like?
>
> Now imagine your job. Do you work alone or with other people? What do you do first thing in the morning? What do you do next?
>
> At the end of the day, how do you feel about your job? What do you like best about your job, and what do you like least about it? Why did you choose this particular job?

This passage may be augmented with specific information about particular industries, careers, transportation, or types of buildings, if you are covering a unit about these in social studies.

After reading students' written responses, compare male and female students' career aspirations and potential use of mathematics. Ask the students to tally responses and summarize. If girls' career aspirations appear to be lower than those of boys, this can serve as a springboard for discussion. If many girls see themselves as homemakers rather than workers, use some of the materials in the "Math Relevance" section to help them understand the need to plan for careers.

Variations

1. Teachers of grades 1–3 can shorten and modify this daydream scenario by asking students to think about: "What will I be when I grow up?" "Will I have a job?" "What will I do?" Early elementary students typically have been exposed to a very narrow range of careers. Use the discussion and materials in the "Math Relevance" section to help students begin considering a wider range of options.

2. In related activity, prepare a bulletin board of children's career choices using drawings or pictures from magazines.

Activity

Going to School—What's the Value of Education to You?

Objective	To encourage students to begin thinking about their future educational plans
Grade Level	Grades 4–6
Time	Three 15–20 minute blocks of time
Materials	"Monetary Value of Education" table on the following page, graph paper, calculators

Procedure

Ask students to write down the number of years they plan on being in school and what "degrees" they plan to get (without putting their names on their papers). Explain that graduating from high school will require 12 years of school, community college will require 14 years, college will require 16 years, and graduate and professional degrees will require 18–22 years.

Have the class tally up how many students are planning to graduate from high school, community college, etc.

Discuss how education contributes to the quality of life—what makes a person happy, and how people achieve happiness. Try to instill a sense of learning as being extremely valuable for its own sake.

Then give students a copy of the "Monetary Value of Education" table on the following page, and let them study the figures. Discuss how education can give people a sense of achievement and provide greater earnings. Be sure to stress both types of value.

Depending on their grade levels, students can then make bar graphs, figure average annual salaries for the class as a whole, etc.

Discuss the material, and have students again anonymously write down the number of years they expect to be in school and the type of degrees they expect to earn. Ask them to write a brief paragraph on the reasons for their plans. Determine whether or not the students, as a group, have changed their educational plans based on the information presented.

Handout

Monetary Value of Education: Average Monthly Salaries

For people who:	*Amount per Month*	*Years in School*
Don't graduate from high school	$ 693	10–11
Graduate from high school	1,045	12
Attend college but don't graduate	1,169	13–14
Get vocational training	1,219	13–14
Graduate from a community college	1,346	14
Graduate from a four-year college	1,841	16
Graduate with a master's (M.S.) degree	2,280	18
Graduate with a doctorate (Ph.D.) degree	3,265	22
Graduate with a professional degree in law or medicine	3,871	22

From Kominski, R. 1987. *What's it worth? Educational background and economic status: Spring 1984.* Washington, D.C.: U.S. Bureau of the Census.

Resources

Askew, J. 1982. *The sky's the limit in math-related careers.* Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

This interesting book describes contemporary women in highly math-related occupations. Each of the chapters—computers, engineering, finance, math education, research mathematics, and statistics—includes several pictures and quotes from women about their jobs and the satisfaction they receive from them. Content is suitable for upper elementary students.

Burns, M. 1975. *The I hate mathematics book.* Boston: Little, Brown.

For those students who "seemingly" hate mathematics, this book provides many relevant activities to boost confidence and aspirations. Positive attitudes toward mathematics develop as students experiment with and investigate the uses of mathematics in solving everyday problems. Suitable only for upper elementary students.

Mitchell, J. S. 1982. *I can be anything: A career book for women.* New York: College Entrance Examination Board.

This book provides specific information on a number of math, science, technical, and nontraditional blue collar jobs. Each entry includes a description of the work, educational requirements, information about women in the field, economic outlook, and sources of further information.

Osen, L. M. 1974. *Women in mathematics.* Cambridge: MIT Press.

This book was written to give students a historical perspective about women in math. Many myths about women in math are exposed, and women's aspirations for mathematical careers are encouraged. The material is suitable for students in grades 5–6.

Perl, T. H. 1978. *Math equals: Biographies of women mathematicians and related activities.* Menlo Park, CA: Addison-Wesley.

Math equals is a teacher resource on the history of women in math and science. The book contains biographies of the lives and work of nine famous women, plus math activities related to the area of mathematics in which each of the women worked. Most of the activities will probably be too difficult for students in grades K–6; however, many of the biographies are suitable reading material for grades 5–6.

Changing Detrimental Attribution Patterns

As used in this guide, the term "attribution patterns" refers to the causes to which students attribute their successes and failures in various life situations. Typically, boys are more likely than girls to attribute their successes to their own abilities, whereas girls are more likely to attribute their successes to luck, easiness of the task, or an outside influence such as a teacher. When accounting for their failures, boys tend to blame their own lack of effort or the difficulty of the task; girls are more likely to attribute failure to their own lack of ability. This attribution pattern occurs even when the abilities and achievement levels of boys and girls are equal. It occurs in many life situations and is particularly debilitating for girls in the area of mathematics. If students believe they are capable of learning or succeeding at a task, but fail because they choose to expend less effort than necessary, they may be encouraged to try harder. But, if students believe that their failure is evidence of lack of ability, they will be more likely to give up. Attributing success to external factors and failure to lack of ability has been linked to a pattern of behavior called "learned helplessness." In this pattern, failure is viewed as inevitable and insurmountable.

- By fifth grade, girls are more likely than boys to attribute poor performance in achievement situations to lack of ability rather than to lack of effort; girls are also more likely than boys to show decreased persistence or impaired performance after failure. (Dweck and Gilliard; Nicholls; both cited in Russo 1985)

- Females are more likely than males to display learned helplessness. (Dweck et al. 1978)

- High math-achieving girls are more likely than any other group of students to attribute their failures to lack of ability. (Wolleat et al. 1980)

- Teachers were found to reinforce typical male/female attribution patterns by being eight times more likely to attribute a boys' failure to insufficient effort than they were a girls'. (Licht and Dweck 1983)

- Both mothers and fathers of boys demonstrated typical male attribution patterns in reference to their sons' math performance; parents of girls demonstrated typical female patterns in reference to their daughters' math performance. (Franklin and Wong 1987)

When children need help, both parents and teachers seem to give boys the message that they have the ability; they just need to put forth more effort. For girls, the message is often that they don't have the ability; less is expected of them. Attribution patterns are highly related to increased confidence and to raised aspirations. Strategies, activities, and resources are presented on the following pages to help you change girls' detrimental attribution patterns.

Strategies

1. Girls who make disparaging comments about their own abilities (even in times of frustration) should be corrected with a positive comment from the teacher. When they know the teacher feels that they do have the ability, most girls become more interested in their own progress. Everyone needs someone to believe she or he is capable.

2. Encouragement and compliments must be specific to be effective, and it is best to praise girls for their *ability* (being capable of solving a problem or doing the work)—*not just for their effort.* (Don't say, "That's okay, you tried.")

3. Effort definitely needs to be encouraged in girls, particularly when they are failing at a task. Stress a "you can do it" attitude for students. Encourage girls to try again and not give up. Stress trying new approaches rather than just "trying harder." Also, stress the old "practice makes perfect" idea.

4. When girls are inclined to dismiss their failure in math because of their parents' past failures ("My mother is no good at math"), it may help to remind them that there is no gene for math ability.

5. Encourage students to talk about their feelings toward success and failure with each other. This may help them see that others attribute their successes to intellectual abilities, not "luck" or circumstances. Small group activities provide excellent opportunities for minimizing self-consciousness about receiving praise from others.

6. Sometimes it can be very helpful to students for their teachers to model failure-persistence-success. Let students know that you sometimes have trouble figuring out a problem; that you have to work hard at it and try new approaches; and that you know if you keep working on it, you will finally find the solution. Model the idea that making mistakes or getting things wrong doesn't mean that we are "dumb," but that we can learn from our errors. Especially if you are a female teacher, let students know that you're a person who has learned to like math and who knows she has the ability to succeed in it.

Activity

Stories about Math

Objective	To expose students to fictitious situations of math successes and failures; to help them learn to attribute girls' successes to ability and failures to other causes
Grade Level	Grades 3–6
Time	15–20 minutes
Materials	Discussion stories below

Procedure

Read each of the brief stories below to the class. After reading each story, ask students the questions listed. Discuss how our abilities combined with effort can lead to success and that failure is not *not* necessarily caused by lack of ability—all of us have ability. Make sure that girls, particularly, understand these concepts.

> Mary Ann got a very good grade on her arithmetic test. When Sue asked her how she got such a high score, Mary Ann said, "I was just lucky."

1. Do you agree?
2. Why or why not?
3. Why do you think Mary Ann did so well on the test?

Encourage your students, especially the girls, to acknowledge that Mary Ann is smart in math—that she has good math ability. They may also come up with reasons that have to do with effort—e.g., she studied a lot—or with receiving extra help from parents or teachers. Make sure your students understand that a high math score definitely indicates ability, although it also requires effort.

> Jessica is not doing very well in arithmetic; she's having trouble with fractions. She says, "I'll never be able to learn fractions; I just can't understand them. I might as well just give up on them."

1. Do you agree that she should give up?
2. Why or why not?
3. Why do you think Jessica is having a problem with fractions?
4. What do you think she can do about this problem?

Sometimes changing the words we use help change our feelings about something. Encourage your students to look at poor performance in an area of math as "having difficulty" rather than "can't do it." Help them see that if Jessica keeps on trying (expends effort and persists) and gets more help that allows her to *try another approach*, she will be able to handle fractions.

> Debra used to like math and do very well in it. But now she doesn't do her math homework, and her grades have started going down. She says, "I guess these low grades mean I'm just not good at math."

1. Do you agree?
2. Why or why not?
3. What can Debra do to bring up her grades?

Help your students see that Debra does have the ability to be good at math (she used to do well), and that she just needs to study more.

> Nancy studied very hard for the big test in arithmetic, and she got the highest score in her class. Her friend Jean said, "Wow, Nancy, you're really good in arithmetic." But Nancy said, "No, I'm not very good in arithmetic, I just study very very hard."

1. Do you agree that studying is the only reason Nancy did so well on the test?
2. What could Nancy have said instead?
3. What would you have said if you were Nancy?

Variation

Substitute male names in these stories and compare students' reactions to the same stories using female names. *Note:* To give this a more thorough test, alternate girl-boy-boy-girl names, then repeat boy-girl-girl-boy names rather than using all female, then all male names.

Activity

Your Abilities Become Skills with Training and Practice

Objective To help students become aware that each of them has multiple abilities

Grade Level Grades 3–6

Time 10–20 minutes

Materials Chalkboard and discussion materials below

Procedure A student's development is often aided by the discovery of existing abilities and skill potential. Provide the opportunity for students to (l) learn what abilities and skills are, (2) learn to recognize abilities and skills in themselves and others, and (3) discover how best to utilize their abilities and skills for their own growth and development. By returning to this activity from time to time, the concept of ability and skills is reinforced, and students' self-concepts continue to grow in a positive direction as they see their own value and potential. It is very important to note that abilities and skills are not dependent on the sex of the individual.

What is an ability?

Ask students to think about this question because you will need some help to define the word "ability." After a few moments, call on a student volunteer to define what she/he thinks the word "ability" means. If no one volunteers, ask a student to look up the word in the dictionary or thesaurus to find the meaning and related words that the class can understand. Write the meaning and some descriptive words on the board.

Once a meaning and a few descriptive words are on the board, ask students to think of some abilities they have (i.e., jumping rope, distinguishing one color from another, threading a needle, reading a book). Have each child write down at least one of his or her abilities on a piece of paper. Pass around the paper, anonymously. After a few moments, ask students to share some of the abilities as you write them on the board. Help students expand the areas they have listed.

As we get older, we learn to do more things with our minds and bodies. We work very hard learning to do certain things until we do them well. As we begin to do things better, our abilities turn into skills. Our abilities and skills continue to grow as we get older.

Go to the list of abilities on the board. Indicate to the students that these abilities can also be considered skills if they are done well. What adult jobs can they name that use these abilities and skills? It should be possible to tie ability to a job,

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i.e., jumping rope indicates physical mobility and could relate to carpentry or house painting, distinguishing one color from another could relate to selling rugs or painting cars. Solicit responses from students, and write job titles next to the ability and/or skill needed.

Variation

Conduct this brief activity again and this time ask students to think of math abilities they have. Then help students relate those abilities to jobs.

Resources

Glennon, L., ed. 1976. *The yellow, blue, and red book.* Seattle, WA: Highline School District, Project Equality.

This colorful three-ring binder is a collection of brief activities developed by and for K–6 teachers to help expand student awareness of traditional sex-role stereotyping. Activities are grouped into three time periods (10–20 minutes, 20–40 minutes, and 40 plus minutes) and have designated subject matter emphasis.

Sargent, A. G., ed. 1985. *Beyond sex roles.* 2d ed. St. Paul, MN: West.

Exercises and information in this book may be used by individual readers or groups to become aware of the sources, scope, and magnitude of female/male sex roles. Although many of the activities require modifications to be suitable for grades K–6, the book contains an excellent discussion of the ways sex roles are learned and reinforced by society. The chapter by Russo on the sex-role socialization process provides particularly good background information.

Stereotyping and Mathematics

Stereotyping means making generalizations about people or things based on commonly held beliefs or societal expectations rather than on actual individual characteristics. For example, we are using gender stereotypes when we believe that boys are "supposed to be aggressive" or that girls are "supposed to be quiet." Another common gender stereotype is the belief that boys have greater mathematical ability than girls. Some people also stereotype mathematics as a "masculine" subject and mathematicians as cold, unfeeling, unfeminine persons.

We are taught stereotypes by our parents, the media, textbooks, peers, and teachers. As girls reach adolescence, the stereotype about femininity and mathematics is one of the important barriers that prevent many of them from forming positive attitudes toward math. One manifestation of this can be seen in high school-age girls who achieve well in math but have low self-concepts and perceive themselves as being very unpopular. According to Fennema and Ayer (1984), when young girls believe that mathematics is inappropriate for them or their sex roles (i.e., not feminine), they feel anxious about succeeding in math and have more negative attitudes toward it. Male peer pressure is also an extremely important factor for adolescent girls.

- Occupational and subject-related stereotypes are well developed in children by grade three. (Hughes et al. 1985)

- Early in their school years, children learn that mathematics is closely identified with the male role; these stereotypes increase with age and become particularly debilitating for females' math achievement (Sheridan and Fizdale 1981); there is a strong negative relationship between the degree of stereotyping and female math achievement. (Boswell and Katz 1980)

- There is a negative relationship between high math achievement and self-image in sixth and seventh grade girls (Roberts et al., 1987); high school girls who were high math achievers rated their popularity extremely low as compared with popularity ratings of high math-achieving boys and those of girls who were high verbal/low math achievers. (Franklin and Wong 1987)

- Girls who took four years of theoretical math exhibited more conflict between sex roles and achievement than did cognitively equated girls who enrolled in fewer math courses. (Sherman 1982)

- High school-age boys and their parents are significantly more likely than girls and their parents to feel that math is more appropriate for males and that males' math skills are superior to those of females (Visser 1986; Franklin and Wong 1987); high school students classify mathematics as a "male" achievement domain. (Stage et al. 1985)

- Northam (1986) studied a number of math books for ages 3–13 that were published in England between 1970 and 1978. In these books, mathematical and scientific skills became increasingly defined as masculine as pupils moved through middle and junior high school. Women and girls almost disappeared from books for ages 12 and 13. In problems, boys and men were typically described in active terms—they were solving problems, explaining to others, devising, planning, performing, and competing. Girls were typically shown repeating or elaborating on a process already learned, cooperating or helping, and correcting another's behavior.

- Female college students are much less likely than males to select math-related majors. (Boli et al. 1984)

- The majority of female Ph.D.'s in mathematics believe that their field is stereotyped by other persons as masculine. (Boswell 1985)

- When asked why more young women do not pursue mathematics-related careers, "fear of masculine disapproval" is often given by parents as a reason. (Franklin and Wong 1987)

- Mathematically gifted girls are very reluctant to skip a grade or to enroll early in college math courses for fear of male peer rejection. Girls who take advanced placement courses in math stress the importance of girl friends' support in helping them deal with the disapproval of boys. (Fox 1981)

Students' needs to establish their masculinity or femininity become extremely important during the adolescent years. If, at that time, girls see mathematics as a "masculine" subject, and if they perceive the world of mathematics as a male-dominated place in which they do not belong, girls will begin to make educational and career decisions that exclude math.

Since gender and math stereotypes appear to develop during the early elementary years, it is critical that we begin to intervene during those years to offer some alternative views for girls. It is particularly important that we also target our intervention efforts toward boys, as well as girls, because boys tend to hold more stereotypical attitudes and because negative male peer pressure can be a very powerful deterrent to adolescent girls' positive math attitudes. The strategies, activities, and resources described on the following pages are designed to change these stereotypical attitudes.

Strategies

1. Word problems in which women are depicted as technical career persons functioning at the center of problems can go a long way toward reducing stereotypes. Be sure your text contains many such examples. If it does not, you can supplement it with your own problems. For example, as an engineer, Mary needed to find out the total weight of vehicles crossing a bridge. If an average of 100 cars crossed the bridge every day and each weighed 700 pounds, how many tons of weight did the bridge handle per day?

2. Simple statistics that chronicle the low percentage of women graduates in math-related fields such as engineering, the lower pay for women, etc., can serve as springboards for discussions about the unfairness of stereotyping in language and social assumptions. These statistics are often available through local school counselors, as well as state and regional sex equity centers. Your state department of education probably has a sex equity coordinator who can provide resources or tell you where to get them.

3. The spoken language is an extremely powerful tool in building and reinforcing or tearing down stereotypes. Be sure that you are not using a generic "he" when referring to students, principals, doctors, etc. Also, don't use a generic "she" when referring to other teachers, nurses, or parents.

4. Just as math-related activities need to be specifically targeted toward a female audience, males must be encouraged to consider female-dominated areas. Whenever possible, display your lack of sex bias by discussing home economics and theater (or other subjects) with boys in mind.

5. For open house night or in a newsletter, prepare a brief pitch to parents to help them become more aware of how their incidental stereotypical remarks about math and women may be damaging their daughters' math potentials. For example, typical remarks might include "that's just like a woman," when someone is unable to solve a math problem or "women are just no good at math" or "she thinks like a boy," when describing a girl who is good at math. Remind parents that "Attitudes are contagious—is yours worth catching?"

Activity

Who Should?

Objective	To generate awareness among students of their own sex-role biases, and to provide them with a framework for becoming open to seeing both sexes in diverse roles
Grade Level	Grades K–6 (You may want to shorten or use only one or two sections of the questionnaire for K–2 students, and administer it orally for nonreaders.)
Time	20 minutes for the questionnaire, plus 10–20 minutes discussion time
Materials	"Who Should" worksheet on the following pages
Procedure	See instructions on the worksheet. Use this questionnaire or any of its sections, to determine the extent of sex-role stereotyping evidenced by your students. Also, use the form as a springboard for discussion in areas where the class openly disagrees.
Variation	You might ask other teachers to give the questionnaire to students in their classes, and complete a school survey of student attitudes. The list of careers used here can be expanded.

Worksheet

Who Should

Student Information

1. Please circle "Boy" if you are a boy or "Girl" if you are a girl.

   I am a: Boy Girl

2. Please circle your grade: K 1 2 3 4 5 6

PART I. For each of these jobs, circle "Woman" if you think only a woman *should* do the job; circle "Man" if you think only a man *should* do the job; circle "Both" if you think both a woman or a man *should* do the job. Be sure to circle only one answer for each job.

3. Airplane pilot	Woman	Man	Both
4. Artist	Woman	Man	Both
5. Astronaut	Woman	Man	Both
6. Carpenter	Woman	Man	Both
7. Cook	Woman	Man	Both
8. Doctor	Woman	Man	Both
9. Engineer	Woman	Man	Both
10. Forest ranger	Woman	Man	Both
11. Lawyer	Woman	Man	Both
12. Librarian	Woman	Man	Both
13. Nurse	Woman	Man	Both
14. President of the United States	Woman	Man	Both
15. Secretary	Woman	Man	Both
16. Scientist	Woman	Man	Both
17. Store clerk	Woman	Man	Both
18. Sixth grade teacher	Woman	Man	Both
19. Telephone operator	Woman	Man	Both
20. Truck driver	Woman	Man	Both
21. Nursery school teacher	Woman	Man	Both

PART II. For the school work and activities listed below, circle "Boy" if you think only a boy *should* do this; circle "Girl" if you think only a girl *should* do this; circle "Both" if you think both a boy or a girl *should* do this. Be sure to circle only *one* answer for each activity.

22. Solve difficult math problems	Boy	Girl	Both
23. Learn to program computers	Boy	Girl	Both
24. Take advanced math classes in high school	Boy	Girl	Both
25. Play games on a computer	Boy	Girl	Both
26. Read poems	Boy	Girl	Both
27. Read lots of stories and books	Boy	Girl	Both
28. Write funny stories	Boy	Girl	Both
29. Learn a foreign language	Boy	Girl	Both

PART III. When there are class jobs to be done, who do you think should do them? Circle "Girl" if you think only a girl *should* do them; circle "Boy" if you think only a boy *should* do them; circle "Both" if you think both a boy or a girl *should* do them. Be sure to circle only *one* answer for each activity.

30. Messenger	Girl	Boy	Both
31. Class president	Girl	Boy	Both
32. Eraser cleaner	Girl	Boy	Both
33. Check out game equipment	Girl	Boy	Both
34. Class secretary	Girl	Boy	Both
35. Water the plants	Girl	Boy	Both

PART IV. Here is a list of spare time activities. Circle who *should* do them: a man, a woman, or both.

36. Play football	Man	Woman	Both
37. Swim	Man	Woman	Both
38. Play the violin	Man	Woman	Both
39. Go to sports events (like baseball)	Man	Woman	Both
40. Gymnastics	Man	Woman	Both
41. Help at a hospital every week	Man	Woman	Both

Activity

Stick Figure Mystery

Objective	To increase vocabulary; to expand occupational perceptions; to reduce sex-role stereotyping
Grade Level	Grades 3–6 (adapt for K–2)
Time	10–20 minutes
Materials	Chalkboard

Procedure

Draw a stick figure on the board or make a transparency of the examples on the following page. Tell students that this is a picture of a person who uses mathematics (or arithmetic) in their work. Instruct students to write down a name for the stick figure, the kind of job the figure is doing, and the math skills required for the job. Ask for volunteers to share the names they chose, job title, and math skills required.

By writing down the students' selections in two columns, one for female responses and one for male responses, it will be apparent to you and the class if girls see girls doing traditionally female jobs, and if boys see boys doing traditionally male jobs. If this is the case for many students, you can then take remedial action.

This activity can be repeated over the entire school term using different stick figures. Once the students are accustomed to the format of the activity they can become responsible for providing the stick figure drawings and leading the class discussions. For ideas on math skills used in jobs, purchase and refer to the chart *When are we ever gonna have to use this?* by Saunders (see annotated resource list).

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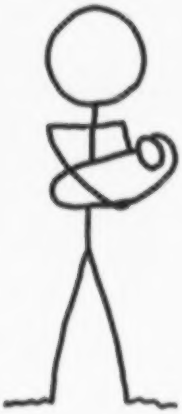
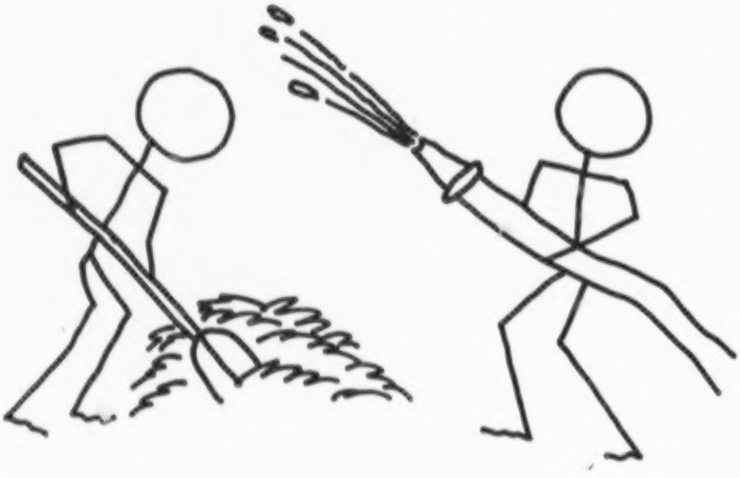
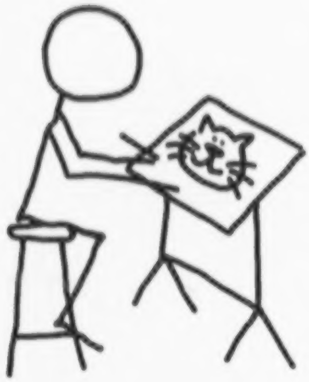
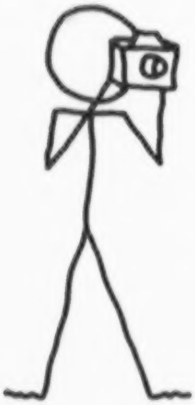
Handout

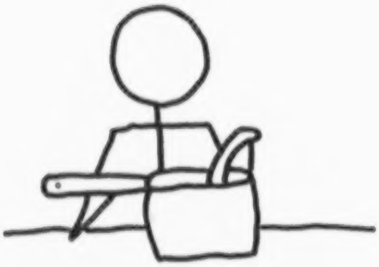
Stick Figure Mysteries











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Activity

Textbook Awareness

Objective	To make students aware of potential and sometimes very subtle bias in math textbooks; to stress an appreciation for the changing and evolving roles of women in professional areas
Grade Level	Grades 4–6
Time	One class period
Materials	Large piece of butcher paper, math books from the 1960s and 1970s (Many schools store these in an old book room, but if yours does not, you may find old copies in the library.)
Procedure	Outline a tally sheet on the butcher paper as shown below.

Women or Girls in Traditional Roles	*Women or Girls in the World of Math*

Divide the class into random groups of three students. Half the groups will use their own books (from math class); the other half will use the vintage texts. You may want to examine some copies in advance to make sure there is actual variation between the books that students can identify. Try to have the groups using vintage texts use the same one.

Discuss the traditional roles of women versus today's roles. Each group will review their books to spot traditional or nontraditional (math-related) roles of females in the story problems, pictures, or in supplementary materials. Let the students know that examples of traditional roles for women can include traditional occupations—teacher, nurse, housewife, etc.—or they can include passive roles such as the assistant or the person who needs help. Students can write the names of the women and the page numbers for reference on their tally sheets.

Have students tally the numbers of women found in traditional and nontraditional roles. Compare the findings for current and older texts in a class discussion. Let students read some examples and comment on the positive changes. Let students discuss how the use of girls' and women's names in problems can subtly give the message that girls can or cannot do math problems. Let students suggest ways of rewriting problems to eliminate sex bias.

Note: If, in your survey, you and your students discover that your current arithmetic text reveals stereotyping and bias in the way females are depicted in problems, have students rewrite problems to correct this bias, and talk to your textbook committee.

Variation

Repeat the process above with a tally for men in the world of math. Compare and discuss the number of instances of men in math-related careers to the number of women in math-related careers.

Activity

Watch Your Language

Objective To become more conscious of language connotations; to reduce sex-role stereotyping

Grade Level Grades 5–6 (adapt for grades 3–4)

Time Two 20-minute blocks of time on successive days

Materials Chalkboard, scratch paper

Procedure [Provide the following background for students]: Sex-role stereotyping is the unquestioned and unchallenged assumption by an individual or a group that certain actions, abilities, interests, behavioral traits, etc., are natural and innate to one sex, but not the other.

Language is a reflection of our thoughts and values and a powerful tool in the learning process. The use of sex-role stereotyping in language is referred to as sexist language. Sexist language can be identified when the language narrows participation or reference on the basis of sex. The following could be considered sexist language:

A man of the people
All men are created equal
A one-man show
A man for all seasons
A twelve-man team
A man-on-the-street interview
One man, one vote
The man for the job

Many of these terms evolved when women did not share in all aspects of life; however, that is certainly not the case today, nor does it fit into projections for the future.

Select two generic traditional terms or phrases from the list above, and list them on the board. Ask students, individually or in groups, to write down as many other ways they can think of to state the concept expressed by the term or phrase on the board. Have students report back to the class their alternative wordings, and list these on the board. Have students explain their new choice of words. This activity can be repeated from time to time to increase students' awareness of the words they use and the words that are used around them.

Variation Encourage students to think up other sexist terms, for example, cleaning woman, manpower, mankind, cover girl, errand boy, handyman, man of the world, doorman, mailman, fireman, etc., and replace them with nonsexist language.

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Resources

American Institutes for Research. 1980. *Programs to combat stereotyping in career choice.* Palo Alto, CA: American Institutes for Research.

In this book, sex stereotyping in career choice is discussed, and nine programs designed to expand students' career awareness and break stereotypical patterns are described. Many of the programs are suitable or modifiable for upper elementary students.

Council on Interracial Books for Children. 1984. *10 quick ways to analyze children's books for racism and sexism.* NY: Council on Interracial Books for Children.

This one-page flier gives parents and educators ten guidelines for evaluating children's books for racist and sexist content.

Fraser, S., ed. 1982. *SPACES: Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are designed for students in grades 4–10.

Glennon, L., ed. 1976. *The yellow, blue, and red book.* Seattle, WA: Highline School District, Project Equality.

This colorful three ring binder is a collection of brief activities developed by and for K–6 teachers to help expand student awareness of traditional sex-role stereotyping. Activities are grouped into three time periods (10–20 minutes, 20–40 minutes, and 40 plus minutes) and have designated subject matter emphasis.

Gordon, R. 1981. *PEER report—ties that bind: The price of pursuing the male mystique.* Washington, DC: NOW Legal Defense and Education Fund.

An excellent summary of the negative effects of sex-role stereotyping on men and boys. This material provides discussion topics about stereotyping for students in grades 5–6.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. Ultimately, the purpose of the program is to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction. Materials are suitable for grades 4–12.

Skolnick, J.; Langbort, C.; and Day, L. 1982. *How to encourage girls in math and science: Strategies for parents and educators.* Palo Alto, CA: Dale Seymour Publications.

This excellent resource examines the effect of sex-role socialization on girls' math/science skills and confidence. It explains how attitudes, parenting and teaching practices, stereotypical play activities and books, peer pressure, and career and family expectations cause girls to question their abilities in math and science, and thus hinder their development in these areas.

In addition to the summary of the socialization process, the book contains a variety of compensatory educational strategies and activities that may be used to encourage females in mathematics. These particularly focus on increasing math confidence, spatial visualization skills, and problem solving. Both parents and educators can benefit from this book.

Part 2

Math Relevance

This section of the guide contains suggestions that will

1. help you increase students' interest in math
2. help students see the relevancy of math in their everyday lives and its usefulness in their future careers
3. provide information on math-related careers
4. provide positive role models for girls

Increasing Interest in Mathematics

Children in the early elementary grades like mathematics and exhibit a fairly high degree of interest in it. However, as they move through junior high and high school, their liking for and interest in math decrease dramatically. This trend is especially true for girls.

- Girls often find math less interesting than do boys. (Fox 1981)
- Girls' low math interest is one of the most important factors in explaining gender differences in mathematics involvement. (Stage et al. 1985)
- Liking for math is related to decisions to enroll in elective math courses; the relationship becomes stronger as students progress through high school. (Armstrong 1985)
- Between sixth and twelfth grades, liking for mathematics declines dramatically for both boys and girls. (Brush 1985)

To make math more interesting for girls, some researchers have suggested stressing its practical rather than abstract and theoretical aspects. Others have suggested introducing more people-oriented problems that deal with real-world situations. We also need to try, as much as possible, to make the math-learning process fun for all students. It is important that elementary teachers try to build on students' early liking for and interest in math. The suggestions on the following pages will help you do this.

Strategies

1. To make even drill and practice fun, divide students into teams, which can be both cooperative and competitive (group-to-group) for students. Besides drill-and-practice exercises, students can also work in teams to solve puzzles and problems. See the section on cooperative learning for more information on group activities.

2. To stress the practical aspects of mathematics, integrate math as much as possible across the curriculum. In language arts class, children can read biographies of women who were successful mathematicians or scientists. In discussing these biographies, emphasize the determination and success of the women.

   Math has many applications in social studies. For example, when studying another country, students can determine its square miles and compare that figure to their own state or to the United States. They can construct graphs of the areas in square miles or drawings to scale, laying one on top of the other for visual comparison. History class presents many opportunities to use math in figuring elapsed time, people's ages, etc.

   Science is probably the subject with the most mathematical applications. Be sure students understand how math is useful in almost all school subjects in solving problems and finding information.

3. To give math problems a more personal flavor, try substituting your students' names in the word problems. Encourage students to write their own problems and think of ways math is useful for them.

4. In teaching math, use many "fun" activities with teasers and problems that are interesting, but within the intellectual grasp of your students. For many students, problems that are too challenging can lead to the view of math as a frustrating subject.

5. Have students carry out a "math scavenger hunt" individually, in pairs, or in groups or teams in which students find objects that can typically be measured in feet, inches, miles, fractions, etc. Also, have students find as many objects of the same shape (for example, triangles or squares) as they can in the classroom.

6. Start a Young Astronaut chapter at your school. Young Astronaut is a national program linking schools to an organization that provides curriculum activity packages, materials, and (on occasion) funds for interesting real-life projects. Each project includes math, science, social studies, and language arts components suitable for grades one through nine. Activities stress elevating math and science skills and interest. For more information, write to the Young Astronaut Council, 1211 Connecticut Avenue, NW, Suite 800, Washington, DC 20036.

Activity

Math Ball

Objective

To identify the numerals 0–9 and indicate the "how manyness" or cardinality of specific numerals; to practice basic computation

Grade Level

Grade 1 (counting, addition, subtraction)
Grades 2–4 (addition, subtraction, multiplication)
Grades 3–6 (combination of computations)

Time

Variable, 15–30 minutes or a free-time activity

Materials

A rubber ball that students can hold or catch in one hand and that bounces readily

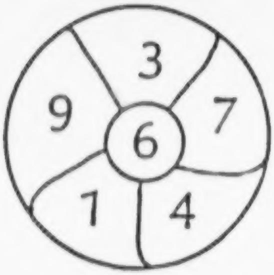
Procedure

Mark the ball into ten sections with a marking pen, and put a single numeral (0–9) in each section. [See illustration below.]

A lower-grade student using the "math ball" might catch it and name the numeral where her thumb (right thumb if two hands are used) is touching the ball. If it is at 4, then she would be asked to bounce the ball exactly four times.

Addition or subtraction could also be accomplished by having the student determine the sum or difference of two numbers touched by her fingers. For example, if the index and little finger are designated and are touching 2 and 9, then 2 + 9 = 11 or 9 – 2 = 7. If desired, the answer could again be bounced.

In fact, multiplication and division as well as a combination of computation processes can be done by many upper-grade students. To accomplish addition, subtraction, multiplication, and division for the numerals touched by all five fingers, the problem might be 5 + 6 – 2 x 7/4, 6 + 7 – 2 x 4/5, or whichever arrangement would yield the greatest or least answer as required.



Variations

1. One variation might involve ordinal as well as cardinal counting. For example, the student might touch 3 on the math ball with her little finger. She would then bounce the ball three times and walk to the third square (the squares might be temporarily made of tape or permanently painted on the floor).

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2. A different type of variation would be to use a sponge-rubber ball and to require the student to catch it in one hand. If she does so, the points scored for that turn would be the sum (or product) of those touched by any two fingers, provided she gives the correct answer.

Activity

Penny Pitch

Objective To reinforce addition and subtraction skills

Grade Level Grades 2–6

Time Variable

Materials "Penny Pitch" game board shown on the following page, a penny or a bottle cap

Procedure Prepare one copy of the game board for each group of student, and give each group a penny to play with. Divide students into groups of 4 or 5. Place a penny (or bottle cap) in the Start position. Demonstrate for students how to give the penny a short, quick push. Add or subtract points according to the numeral spaces that the penny is touching. For example, if the penny lands where two lines intersect, those four numbers can be added to the student's score (only correct addition would be counted). The first person to score 100 points wins.

Variations

1. You may also wish to utilize Penny Pitch as a multiplication activity. As such, each number the penny touches could be multiplied by a designated factor such as 4. Thus, if the penny lands on 5, the player's score for this turn is 4 x 5 = 20, but if the penny touches 2, 6, 14, and 11, her score is 4 x (2 + 6 + 11 + 14) or 4 x 33 = 132. The first player to reach 500 or 1,000 would be designated the winner.

2. Another good way to play this game would be to designate one student to referee each group. The referee can use a calculator to check the accuracy of each player's calculations and to verify each player's total score.

3. For younger students, make a game board with only single-digit numbers.

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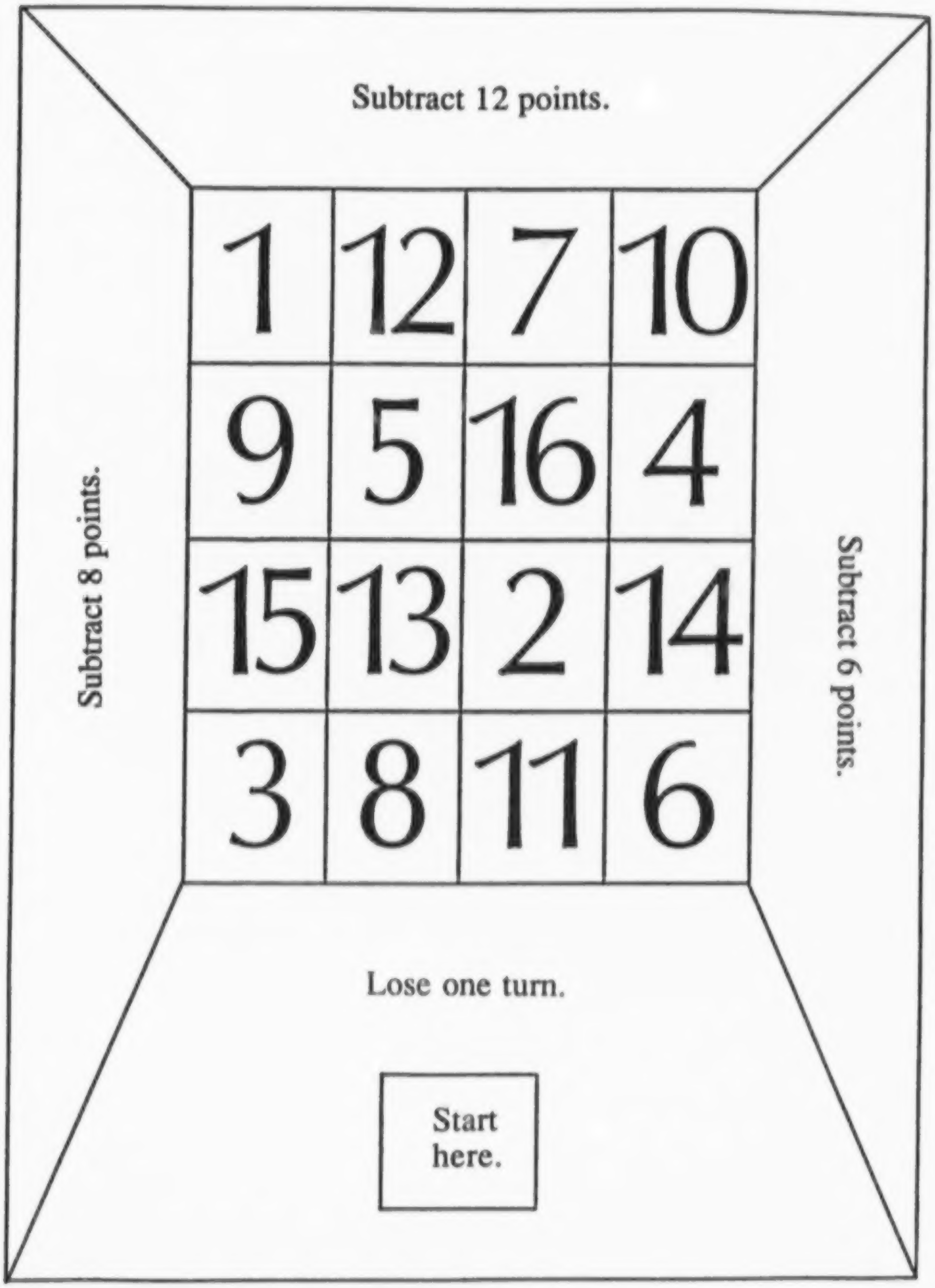
Handout

Penny Pitch



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Activity

Find a Million

Objective

To help students obtain a visual concept of the size of a million; to develop the place value concepts of how many thousands and hundreds there are in a million; to practice reading and computing large numbers

Grade Level

Grades 4–6

Time

Variable (This activity can take up to four class periods, and may be used as an ongoing project for individual students to work on during short periods over a week or two. Time spent on the project will reinforce the immensity of the number.)

Materials

Approximately 130 copies of a ditto master with about 8,000 dots on it (the sample on the next page has 67 x 120 = 8,040 dots), marking pens or crayons

Procedure

[Most of us cannot really contemplate the magnitude of very large numbers because we have no sensory reference point. This activity will help students better understand large numbers.] Have students determine how many dots there are on one page. Once they have completed this task, ask how many pages it would take to make a million. They might accomplish this via repeated addition, multiplication, trial and error, or division. Have students verify their answers with hand-held calculators. Using pages like the sample, it will take slightly less than 125 full pages (or 125 pages exactly if there are 8,000 dots per page).

Next, have students put the pages on a bulletin board, wall, or floor until they have a million dots displayed. Now ask how many hundreds there are in a million. Have them mark the dots off a hundred at a time using different colored marking pens or crayons. When they have solved this problem correctly, have students determine how many thousands there are in a million. Complete the same process for ten thousands, and hundred thousands. Since this project requires so much paper, you might want to laminate the sheets so they can be used from year to year.

Variation

You may use the dots to show everyday data that need to be expressed in large numbers. For example, you might find the dots to show the population of your community, the number of new cars purchased in your state, etc. Such information can readily be obtained from an almanac or other reference book.

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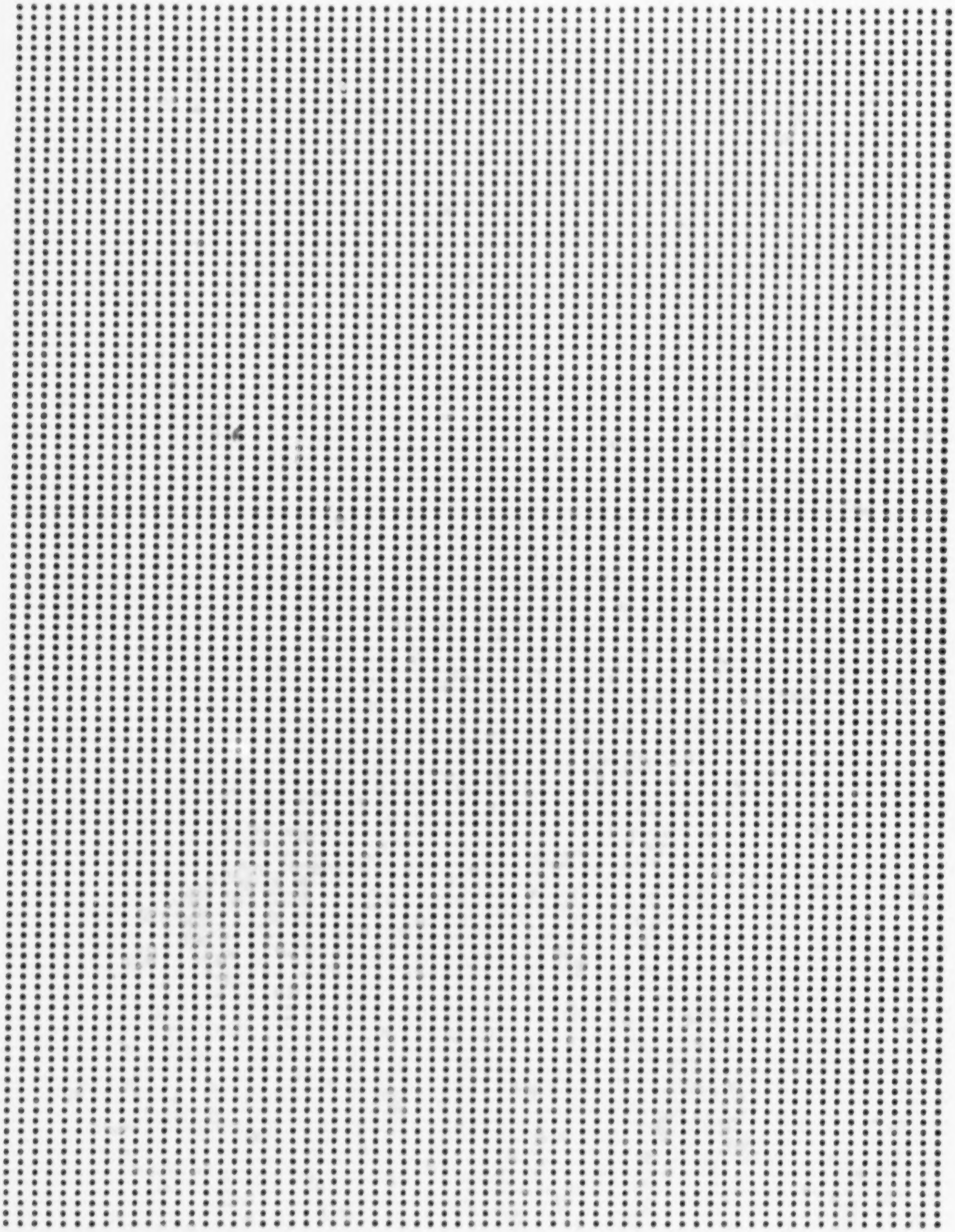

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Activity

The Perfect Room for Me

Objective

To allow students to manipulate materials with a practical significance to their lives, increase the concreteness of spatial visualization concepts by relating objects to their scale sizes, and utilize skills in addition and subtraction of fractions (This lesson may also be geared specifically to whole numbers.)

Grade Level

Grades 4–6

Time

Up to two math periods (can be done as an outside or take-home activity)

Materials

Graph paper; rulers; measurements of twin beds, double beds, desks, chairs, television sets, stereo equipment, etc. (These measurements can be obtained by the teacher, assigned to students to determine from their present rooms, or selected from furniture catalogs.)

Procedure

Ask students to think about and design their ideal rooms. As an introduction to the concept of floor plans, you may want to acquaint them with house plans in a limited manner—especially noting the "to scale" measurements, which relate to actual space. To introduce the concept, draw a floor plan of your classroom—everyone is familiar with this space. Discuss measurements of the objects identified by elements in the drawing.

Have students draw a "to scale" version of their ideal rooms. Stress that money and resources are unlimited. (Since "unlimited resources" do not reflect real life, you might prefer instead to give students a maximum room size or ask them to stay within a budget.)

In order to simplify the process for them, you may want to establish the scale of measurement most appropriate to the graph paper you've distributed.

As an additional art idea, have each child draw and color a picture of the interior of their ideal room.

Variation

Have students make "to scale" templates for various pieces of furniture. Laminate these for future use.

Activity

Team Youth Scrabble

Objective	To encourage students' addition and estimating skills in a team situation; to generalize math skills to other areas of students' experiences; to promote cooperative learning in mathematics-related class work
Grade Level	Grades 5–6
Time	20–40 minutes
Materials	Overhead projector, one or more Scrabble game sets (preferably the youth version), a transparency of the game board
Procedure	Divide the class randomly into teams. To induce cooperation require each member of the team to take a turn. Cooperative learning occurs when enough time for response is alloted so that the player may be coached by others on the team. Ask students to justify their answers. This will promote their internalizing what teammates have recommended. Use an overhead projector to project the game board so that all teams can see it or recreate a Scrabble board on large poster board (laminated), and have students sit around it on the floor to play. Abiding by the Scrabble rules, students must identify the largest-counting words. Even students whose addition estimation skills are not near the top of the class can achieve team success by offering words with high-counting letters.

Activity

"Math Facts" Scavenger Hunt

Objective To increase interest in numbers and mathematics

Grade Level Grades 5–6

Time One class period

Materials Worksheets and calculators, lists of "math facts" questions for the scavenger hunt (see examples below)

Procedure Compose a problem that your students will have to solve by finding a number of "facts" they may not already know. Examples of problems are given below.

1. Find the number of windows in our school building; divide by the number of bones in the human body; multiply by the number of states in the United States with the letter *t* in their names.

2. Take 80% of the number of keys on a standard typewriter; add the number of elements; divide by the number of days in a leap year minus 3; multiply by 1/2; subtract the number of counties in your state.

This activity may be done in teams or by individual students. It is also a good activity for math class. The activity can be used to emphasize learning in certain subject areas, such as science, health, geography, and so forth.

Variation Encourage your students to develop their own problems. (The student who poses the problem must also come up with a correct answer.)

Activity

Math Clubs

Objective	To promote math interest and fun in a positive, nonthreatening atmosphere
Grade Level	Grades 5–6
Time	30–40 minutes during lunch hour or before or after school
Materials	See Resources list on the following pages for ideas

Procedure

Stimulate interest in mathematical investigation through exciting topics not usually discussed in the classroom.

Invite interested students to participate in a math club during activity time (lunch, after school, before school, etc.). Students can play the math games that they enjoyed during class, but didn't have enough time to complete (pentomino puzzles, perceptual puzzle blocks, or polyhedra dice). (Many math games may be found in the Creative Publications catalog available from P.O. Box 10328, Palo Alto, CA 94303.)

Have students form teams for math tournaments. Run the activity with playoffs, and issue some type of awards. Have students sponsor and support the school or community in fundraising activities that will promote the math club in a positive manner. Encourage parents to participate in and support the club.

Resources

Barrata-Lorton, M. 1976. *Mathematics their way.* Menlo Park, CA: Addison-Wesley.

Mathematics their way features an activity-centered manipulative math program in which children learn through using all five senses. The curriculum consists of many activities that focus on counting, classifying, graphing, estimating, and measuring. All activities are appropriate for students in grades K–2. The program teaches math concepts so that all children understand them regardless of their abilities.

Barrata-Lorton, R. 1977. *Mathematics, a way of thinking.* Menlo Park, CA: Addison-Wesley.

This book describes an activity-centered manipulative mathematics program for grades 3–6. The program is similar to the one presented in *Mathematics their way.*

Burns, M. 1982. *Math for smarty pants.* Boston: Little, Brown.

This book contains a wide range of accessible activities presented in an entertaining format. It would be particularly useful for expanding upper elementary students' perceptions of mathematics.

DeRoche, E. F., and Bogenschild, E. G. 1977. *400 group games and activities for teaching math.* West Nyack, NY: Parker.

This book includes 400 classroom-tested math strategies and activities suitable for use in cooperative mathematics learning for elementary and junior high students. The activities are enjoyable and focus on the practical implications of learning math in a cooperative classroom atmosphere.

Downie, D.; Slesnick, T.; and Stenmark, J. K. 1981. *Math for girls and other problem solvers.* Berkeley: University of California, Math/Science Network.

The activities in this book encourage independent thinking and creativity in mathematics. Students and teachers are encouraged to think about problem solving in versatile ways and forms. Although this book was originally designed for females, the activities are appropriate and interesting to both boys and girls, ages 7–14.

Fennell, F., and Williams, D. 1986. *Ideas from the arithmetic teacher: Grades 4–6 intermediate school.* Reston, VA: National Council of Teachers of Mathematics.

This is a collection of classroom-tested activities from the journal *Arithmetic Teacher.* Perforated pages allow easy duplication of activities, which can be used for supplementing, extending, or reinforcing daily mathematics lessons in numeration, whole number computation, rational numbers, geometry, measurement, and problem solving. Objectives, grade levels, directions, and answers are given for each activity.

Fraser, S., ed. 1982. *SPACES: Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are designed for students in grades 4–10.

Howard, B. C. 1982. *Mathematics in content areas (MICA). A teacher training approach.* Washington, DC: Office of Education, Teacher Corps.

This resource details an agenda for an in-service program to develop elementary and secondary teachers' mathematical abilities and to help them integrate and teach mathematical concepts across the curriculum.

Jensen, R., and Spector, D. 1984. *Teaching mathematics to young children.* Englewood Cliffs, NJ: Prentice-Hall.

This teacher and parent resource suggests many activities that can be used to explore math concepts with young children. The suggested vehicles for math instruction—including manipulative and creative movements, art activities, and games—allow children to tackle new ideas while developing problem-solving skills. Chapters and activities are organized from the concrete to abstract, so that young children may master mathematical concepts and gain confidence in learning.

Joels, K. M. 1985. *Young astronaut program: Chapter leader's handbook.* Washington, DC: Young Astronaut Council.

This handbook describes the Young Astronaut program, which provides curriculum packages for grades 1–9 that stress math and science activities. The activities and materials are presented in a very interesting way, and by linking them to the space program, a continuing source of interest and motivation is provided for students.

Massialas, B. 1983. *Fair play: Developing self-concept and decision-making skills in the middle school: Decisions about mathematics* (Student guide). Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

Decisions about mathematics includes many real-life activities to interest middle school students and to promote math-related careers. Activities are organized around the topics of "Math and money," "Collecting and analyzing data," and "Your future."

Overholt, J. L. 1978. *Dr. Jim's elementary math prescriptions.* Santa Monica, CA: Goodyear.

Dr. Jim's elementary math prescriptions is a resource for educators of grades K–8 who are searching for effective methods of teaching mathematics. Each mathematical concept is presented with alternative methods to accommodate students with varied learning styles, abilities, and interests. Selected activities provide enjoyable mastery practice, so that students will develop mathematical competence and appreciation.

Silvey, L., and Smart, J. R., eds. 1982. *Mathematics for the middle grades 5–9.* Reston, VA: National Council of Teachers of Mathematics.

This book was developed to aid teachers in promoting the mathematical development of students in grades 5–9. The book cover critical issues in mathematics education, unique learning activities, and strategies for teaching problem solving.

Smith, S., and Backman, C., eds. 1975. *Games and puzzles for elementary and middle school mathematics: Readings from the* Arithmetic Teacher. Reston, VA: National Council of Teachers of Mathematics.

This book contains more than 100 articles on the use of games and puzzles to capture students' interest and imaginations.

Making Math More Relevant and Useful

Many high school students do not see how mathematics is relevant to their daily lives or how it will be useful in future careers. The way we teach math does not often emphasize its usefulness to students. Because the utility value of mathematics, as perceived by students, has been found to be a strong predictor of enrollment in elective math courses in high school, it is important that we stress the ways math can be used while we teach math skills to students.

- Both male and female students who perceived math as useful to them were more likely to persist in its study. (Pedro et al. 1981)
- Perceived usefulness of mathematics is also related to math achievement in high school. (Chipman and Wilson 1985)
- As early as seventh grade, boys rate math as more useful than do girls. (Stage et al. 1985)
- Although gender differences seem to be narrowing, boys still judge mathematics to be more useful for themselves than do girls. (Chipman and Wilson 1985)
- In a study of senior honors English students, very few could think of a way that they currently use mathematics in their daily lives. (Franklin, Mueller, and Blankenship 1987)

The suggestions on the following pages should give you some ideas about how you can introduce more information about math usefulness, while still using class time to teach math skills and concepts.

Strategies

1. Stress real-life problems in math. Search your classroom environment for math-related problems that are relevant to students' immediate lives and needs. For example, how many children may play softball at the same time with the equipment you have? Determine the average number of writing implements in each desk; the number of minutes for each child at the computer, given the number of children, computers, and computer time; or the average number of minutes students spend sleeping, watching television, or at play.

2. Lead a fantasy discussion wherein students imagine how their favorite television or cartoon characters use math in their pretend lives.

3. Select a group of lunch preference counters who collect data for the class, make graphs of changes in hot lunch eating patterns, and possibly even determine the cafeteria's best meals.

4. When planning class parties, fund raisers, etc., let the class determine the amounts of ingredients, the costs of items, the profits, etc.

Activity

Math in My House

Objective	To make students aware of the various ways their parents use mathematics in their daily lives; to help involve parents in their children's math education
Grade Level	Grades 2–6 (The activity may be more or less sophisticated depending on the students' levels of achievement.)
Time	20–40 minutes (This activity will be partially done at home; in-class time will depend on the level of reporting you require.)
Materials	Graph paper or chalkboard, copies of "Math in My House" tally sheet on the following page
Procedure	Design an answer or tally sheet (or use the one on the following page) that students may take home to record their answers. Plan the questions students will ask their parents about the ways the parents use mathematics, e.g., how do they use math to pay bills, do taxes, invest, budget, cook, sew, do woodworking, garden, and so on. For younger students, make a written list of questions for students to take home. After interviewing their parents, older students can prepare data summaries, graphs and charts, figure averages, etc. Questions they may want to cover include: What math skills are used most often? Who uses math in more ways—mothers or fathers?

Worksheet

Math In My House

Ways My Mother Uses Math at Home	*Math Skills Needed*

Ways My Father Uses Math at Home	*Math Skills Needed*

Activity

TV Hours

Objective To determine the number of student TV-viewing hours in one year

Grade Level Grades 3–6 (can be modified for grades 1–2)

Time 30–40 minutes

Materials Graph paper, tally sheets

Procedure Families watch varying amounts of television. To complete this activity, you will want to try and select an "average week" of TV viewing. The results will depend on how "average" the week is. Each student should record the number of his or her TV viewing hours for one week. The TV hours for one week multiplied by 52 is an estimate of the annual TV-time commitment.

The table below is a sample record of one week's viewing.

	TV Hours
Monday	3
Tuesday	2
Wednesday	3
Thursday	4
Friday	2
Saturday	6
Sunday	5
Total for week	25
Total for year (x 52)	1,300

This student watched about 1,300 hours of television in one year. If more or less television viewing took place during the week sampled than throughout the rest of the year, the total viewing hours would of course be inaccurate. However, for our purposes, the estimate is probably accurate enough. If more accurate results are desired, sample two or three randomly chosen weeks throughout the year and compute the total based on the average of the weekly figures. Some discussion of differing viewing habits during holidays and vacations might also be necessary.

To modify the activity for younger children, let each student make a bar graph by coloring one square for each hour she watches TV on each day.

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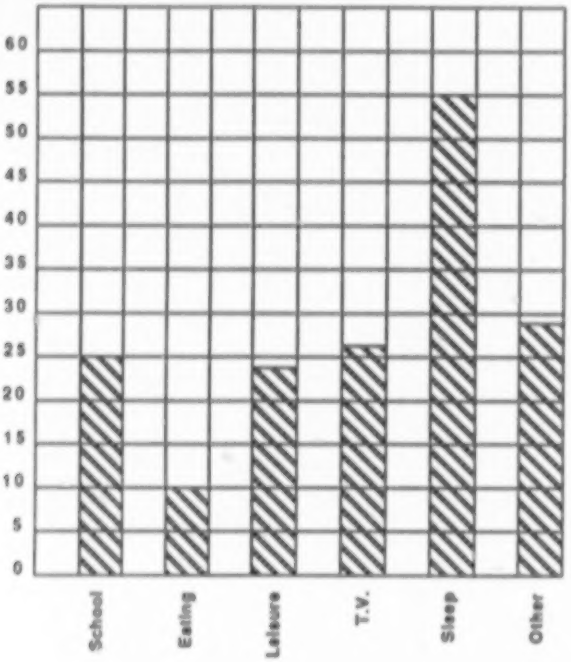
Variation

It is also fun to compute the number of hours students are engaged in school, eating, playing, and sleeping. The results can easily be graphed as shown below, offering a clear picture of life patterns. Each child can construct a general graph, or an average class graph can be developed to show overall patterns. For younger children, construct the graph based on one week's activities.

What Is Your Life's Pattern?



The weekly graph above doesn't tell the whole story, however. Since school is generally in session for 36 weeks, and if we assume TV viewing patterns are consistent throughout the year, this student attended school for only 900 hours and watched 1,300 hours of television . . . an excellent topic for discussion.

Other topics of interest that can be effectively investigated using graphs include favorite foods, pets, TV programs, sport heroes, number of brothers and sisters, and a birthday graph showing number of students with birthdays for each month.

In the primary grades, real graphs are an effective way to show relationships. To respond to questions such as number of brothers and sisters, children can stand in designated squares on the floor; e. g., all those with no siblings stand together in the first large square; all those with one sibling stand together; etc. The number of students standing in each square represents a line on a real graph. Another way to make real graphs is to use the chalkboard to make a large box for each alternative question. Put each student's name in the appropriate box.

Activity

Class Allowance

Objective

To determine how much the whole class spends in a year; to help students learn to make responsible consumer decisions

Grade Level

Grades 4–6

Time

Variable, depending on follow-up activities

Materials

Calculators (if available) and graph paper

Procedure

Many children don't realize how much money they spend over a period of time. In this activity, individuals or small groups work out their spending habits for a year. Approximate weekly income and spending should be estimated for each student. If necessary, discuss different spending trends during the summer and holidays. Savings should be kept as a separate category. Use a calculator to total spending for the whole class, and multiply by 52 to find yearly consumer power.

[Although many students do not receive allowances, most do receive money to spend on themselves.] Have each student total up personal spending for one week. Include milk and lunch money, allowance or earnings spent on school supplies, food, toys, comic books, etc. Include only money that children actually spend themselves (not money spent "on" them). It will be necessary to discuss approximation and estimation skills. Your class will need to understand what "average spending per week" means, as well.

Once everyone has computed their estimated average weekly spending, organize the results in a table, and have the class fill in their own personal record sheets. Have each student compute the class total for a week and multiply by 52 to find their yearly consumer power. Encourage the use of calculators for these computations.

This problem clearly demonstrates the usefulness of gathering statistics in order to investigate an everyday occurrence. Your class (and you) may be surprised at the amount of purchasing power in the five through twelve-year-old segment of our society. (Saturday morning TV advertisers would not be surprised, however.) The results of this problem can provide the basis for a most interesting values clarification activity to help children make responsible decisions in the marketplace.

Variation

After using the process described in the initial exercise above, distribute popular toy fliers (Toys R Us, K-Mart, JC Penney, etc.) and have students determine how their incomes can or cannot support their desires. Students can also plan for item purchases through savings.

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Activity

Figuring Out Food

Objective	To allow students to see the relevance of math skills to their lives by using mathematics in basic food planning
Grade Level	Grades 4–6
Time	Two 20-minute periods, plus additional time outside class
Materials	Copies of limited calorie chart (This information is available in many cookbooks, health texts, and county extension offices.)
Procedure	Describe the basic food groups and the importance of good nutrition with selections from each. Prepare and distribute the calorie chart. Have students select foods with two requirements: (1) a balanced diet and (2) appropriate caloric intake for themselves. Students may plan one day's menu or an entire week's menu, individually or in groups. This will require addition and subtraction as well as analytical strategies.
Variation	Students can also keep a "food diary" noting the foods they eat; then count up their caloric intake per day, using calorie charts. This food diary activity can be extended to let students determine differences in eating patterns before and after studying food groups and calories.

Activity

Buying My School Clothes

Objective

To demonstrate to students how math skills are needed and used in making consumer decisions; to teach the value of money

Grade Level

Grades 4–6

Time

15–30 minutes

Materials

Copies of children's clothing sections from current catalogs

Procedure

Ask the class to decide (by vote) how much money would be needed to buy a student's school clothes assuming all of his or her clothes had disappeared. Once the class has settled on a figure—i.e., $100, $500, or whatever—pass out copies of catalogs, and let students select the clothes they would buy for the total amount of money, keeping track of the amount per item and the cumulative total. Your students may originally come up with figures that are way out of line—either too little or too much. After preliminary tries, help them settle on a more realistic amount.

Variations

1. Before the students settle on an amount, let them look at the catalogs and estimate the necessary amount. In most cases, this should lead to more realistic outcomes than the first procedure.

2. Let students compare prices for comparable items from today's and very old catalogs. Your local library or historical society probably has copies of catalogs from the early 1900s. Many activities on differences, percentages, averages, and so on can stem from this exercise.

3. In addition to estimating the amounts of money necessary to purchase school clothes, students can also use the catalogs to select Christmas presents within a budget or to furnish a room. Using travel brochures, students can plan vacations within certain budgets.

4. It would also be instructive to have students figure out how many hours they would need to work to purchase the clothes if they earned $4 per hour.

Activity

Numbers in Our World

Objective	To provide students with an awareness of the usefulness of math study; to generate interest in observing adults' usage of math skills
Grade Level	Grades 4–6
Time	30–45 minutes, with possible follow-up
Materials	Six copies of the "Numbers in Our World" score sheet on following page
Procedure	Divide your class randomly into six groups of equal size. These will function as teams that will "brainstorm" a topic area. Write the following topics on slips of paper and have each team draw one: (a) math at home; (b) math in medicine—doctors, veterinarians, nurses; (c) math in my city—police, firefighters, detectives; (d) math in stores; (e) math in government—the President, governor, and mayor; and (f) math in television. Provide each team with a score sheet (see next page) to keep track of their ideas. Remind them that they may need to show an example for each way math is used. After 20–30 minutes, call "Stop." Prepare a tally on the board as groups take turns reporting one idea at a time. Continue until all have been recorded.
Variation	You may allow students to take score sheets home to get help from their parents. Have them reconvene with their groups before scoring the final tally on the board.

Worksheet

Numbers in Our World

Name ____________________

Math topic ____________________

Group members ____________________

____

____

____

	Ways Math Is Used	*Examples*
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

Total = ______

Activity

Our House Beautiful

Objective	To help students understand the importance of math in skilled technical occupations
Grade Level	Grades 4–6
Time	At least four 30-minute blocks of time, plus additional time at home
Materials	Drawing paper, rulers

Procedure

Invite a local builder to display house plans and discuss the math used in their preparation. Perhaps you would like to consider an architect—anyone who would feel comfortable describing the house design and construction profession would be a good choice. A female architect would be ideal.

Invite the guest lecturer to bring plans, elevations, photographs, and models of her/his work. During the talk, she or he can describe how room size is calculated from total square feet and how drawings are prepared.

Subsequent to this visit, the class can design their own house. Ask students to prepare elevations. These drawings can be displayed on the bulletin board. Have the class vote on their favorite house. Then, using the selected house, students can divide its space into various living areas: bedrooms, bathrooms, living room, dining room, kitchen, etc. Each space can be designed individually or in teams. The class again votes on the best effort and assimilates the design into the house. Make sure that each student has input into the house design. This activity should provide students with practice drawing to scale, measuring, calculating, and visualizing spatial relationships. At the end of the activity, help students relate the math skills they have practiced to the skills they would need to work in the building and construction industry.

Resources

Burns, M. 1975. *The I hate mathematics book.* Boston: Little, Brown.

For those students who "seemingly" hate mathematics, this book provides many relevant activities to boost confidence and aspirations. Positive attitudes toward mathematics develop as students experiment with and investigate the uses of mathematics in solving everyday problems. Suitable only for upper elementary students.

DeRoche, E. F., and Bogenschild, E. G. 1977. *400 group games and activities for teaching math.* West Nyack, NY: Parker.

This book includes 400 classroom-tested math strategies and activities suitable for use in cooperative mathematics learning for elementary and junior high students. The activities are enjoyable and focus on the practical implications of learning math in a cooperative classroom atmosphere.

Fraser, S., ed. 1982. *SPACES: Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are designed for students in grades 4–10.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. Ultimately, the purpose of the program is to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction. Materials are suitable for grades 4–12.

Massialas, B. 1983. *Fair play: Developing self-concept and decision-making skills in the middle school: Decisions about mathematics* (Student guide). Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

Decisions about mathematics includes many real-life activities to interest middle school students and to promote math-related careers. Activities are organized around the topics of "math and money," "Collecting and analyzing data," and "Your future."

Saunders, H. 1981. *When are we ever gonna have to use this?* Chart. Palo Alto, CA: Dale Seymour Publications.

If you want a quick answer for the students' proverbial question "When are we ever gonna have to use this?", order this attractively done wall poster. The chart gives students information on just which careers require knowledge of specific math concepts. The chart can also be useful for developing your own math-in-careers activities.

Souviney, R. J. 1981. *Solving problems kids care about.* Palo Alto, CA: Scott, Foresman.

Solving problems kids care about is divided into two parts. The first section includes notes and strategies for teaching mathematical problem solving. The second section contains thirty real-world problems that encourage divergent and logical thinking. Many of the problems have a range of acceptable solutions and multiple solution strategies, so students have the opportunity to be creative and independent thinkers. Activities are designed for elementary through junior high school students; teachers will enjoy them also.

Providing Information on Math-Related Careers

Students' awareness of math-related careers increases their understanding of the usefulness of mathematics. Typically, teachers at all levels—elementary through high school—spend little or no class time discussing the careers for which mathematics is important. Therefore, students often make uninformed career decisions. Again, this is more often true for girls, who typically choose traditional careers very early in their lives, before they have received enough information about other possibilities. Girls also often exhibit uncertainty of goals and lack of career planning.

- Girls continuing the study of math were more attuned to career plans than those not electing to continue high school math studies. (Stallings 1985)
- Students are generally poorly informed about the actual uses of advanced mathematics, and their perceptions of the mathematical requirements of their career choices may be inaccurate. (Chipman and Wilson 1985)
- Much evidence indicates that teachers and parents reinforce boys for learning math and for planning math-related careers more than they reinforce girls for these activities. (Grayson and Martin 1988)
- Girls are or have been less well informed about the uses of mathematics than boys. (Chipman and Wilson 1985)
- There are large gender differences in students' reasons for working and their expectations for full-time careers. Boys typically expect to work full time, whereas many girls expect to have an interrupted or a part-time career (Fox et al. 1985). Boys see a career as a financial necessity or as a societal requirement; girls expect their future careers to provide challenge and personal fulfillment. (Franklin and Wong 1987)
- Even at the junior high level, girls' career preferences are related more to traditional sex role-related interests than to realistic assessment of their own mathematics achievement levels and abilities. (Jacobowitz 1983)

To help students understand why they need to learn math and how it can fit into their future career plans, we need to provide more information about math-related careers. The suggestions on the following pages include some strategies and activities that you can use to help students begin thinking about math and careers.

Strategies

1. Invite guests, both male and female—who are enthusiastic about their work—to speak to the class about how they use math in their jobs.

2. Have students conduct a survey of the adults they know, asking what they do for a living and how they use math in their occupations.

3. Have students generate a list of television personalities who use math on their shows in some way. A supplementary assignment could be role-playing, where students enact an episode of this character using math.

4. Display posters on careers in math (see resource list at the end of this section), and take a few minutes before lunch, before going home, and so forth to make the poster a game. Ask what a particular career is, have a student look it up to report to the class, have him or her speculate what this person does, and ask if any of your students are considering this as an occupation.

5. Math textbooks sometimes include supplementary material describing careers that are linked to current course work in math. Take every opportunity to discuss these occupations, to encourage students to work toward them, and (where possible) to report incidences of women employed in these fields.

6. Use the career stories in the "Providing Positive Role Models for Girls" section of this guide, plus descriptions of careers found in some of the resource books listed. Discuss how people in these careers use math.

7. Although career information in counselors' offices varies by school, it is generally acknowledged that counselors, especially at the high school level, are well-supplied and well-versed in career-related information. Invite them to make presentations to your classes and to target girls for careers in science and math areas.

8. The "Job Sort" and "Odds on You" games found in *Use EQUALS to promote the participation of women in mathematics* by Kaseberg et al. and the "Math Used in Jobs" game found in *SPACES* by Fraser (see resource list) are excellent aids to help students begin to think about occupations, careers, and the education they will need.

9. Some elementary schools have several "dress-up days" throughout the school year. Ask your students to dress like someone in an occupation that uses mathematics; then have each student tell how they would use math in that job.

Activity

Who Uses Math?

Objective

To help young children become aware of different occupations and how each uses mathematics

Grade Level

Grades 1–6 (vary the complexity depending on grade level)

Time

20–30 minutes (can be used as a continuing activity)

Materials

Poster chart *When are we ever gonna have to use this?* or a copy of the article by Saunders, also career information books (see resource list) (The poster is available from Dale Seymour Publications, P.O. Box 10888, Palo Alto, CA 94303 [order no. DS01344].)

Procedure

Select from the chart or the article about ten occupations that you think the children in your class are already familiar with, e.g., airplane pilot, artist, carpenter, dentist, doctor, librarian, nurse, plumber, police officer, cashier, and veterinarian. Put the name of each occupation on the chalkboard.

For each occupation, ask students how many think this is mostly a job for a man, mostly a job for a woman, or a job for any person. Clear up any misinformation about sex roles at this time.

Then, using information from the career books, help students come up with at least one tool that each of these persons use on the job; one place where each does their job—i.e., an office, a laboratory, a hospital, outdoors; and one way each uses mathematics.

Depending on the math concepts you are currently studying, let students make up math problems about each person in her or his occupation. For example, "The speed limit was 50 m.p.h. The police officer stopped a car that was traveling at 67 miles per hour. How much over the speed limit was the car going?"

When your students have learned about the first ten careers, introduce additional sets of ten new occupations. For each group, help students learn what the persons do, the tools they use, where they carry out their jobs, and the ways they use mathematics.

Variation

Have students find pictures of people in each of the occupations. After you have collected 20–30 occupations with tools and places, another activity would be to produce a matching test for students or a fill-in-the-blanks game—i.e., a police officer uses a (tool)__________ (where)__________.

Activity

Stimulating Interest in Math Careers Using Outside Sources

Objective	To help students become aware of the need for mathematics in the world beyond the formal setting of the classroom
Grade Level	Grades 5–6
Time	Variable
Procedure	Many school districts are featuring "Career Days" for middle school and high school students, and it is important that upper elementary students also attend. Find out about these activities, and make sure your classes are included as participants.
Variation	Arrange for field trips that allow students to observe how studying math will enable them to pursue interesting careers. Suggestions include universities or colleges, the telephone company, water treatment facilities, and other large technical or professional companies. Plan the field trip with the intent to stimulate further study of math.

Activity

Classify the Classifieds

Objective

To allow students to discover the relative number of males and females in some professions and learn about a variety of careers; to develop and practice skills in tallying, computing percents, researching information from original sources, and constructing charts and graphs

Grade Level

Grades 5–6

Time

Three or four 30–40 minute periods

Materials

Copies of the Yellow Pages phone book from a large metropolitan area; copies of the "Tally Sheet," "Chart of Classified Occupations," and "Graph of Yellow Page Occupations" worksheets on the following pages; crayons or colored pens

Procedure

Obtain a copy of the Yellow Pages phone book for every two students. The books can be local or out-of-town and need not be current. Books are often available free from your local phone company, or students can bring borrowed books from home for one day. Give each pair of students a copy of the "Tally Sheet," use one copy of the "Chart of Classified Occupations" for the entire class, and give each student a copy of the "Graph of Yellow Page Occupations" worksheet.

Tell students that they will use the Yellow Pages to look up several professions. By identifying first names as male or female, they can calculate approximately what percent are men and what percent are women in these professions.

Some occupations that will probably be listed in your local telephone book include:

- Accountant
- Architect
- Attorney
- Dentist
- Engineer: civil, consulting, mechanical, structural, mining, electrical, and many other breakdowns
- Optometrist
- Physician: pediatrician, psychiatrist, general practice, surgeon, and many other breakdowns

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Before distributing the phone books, help the class generate a list of occupations that are listed in the Yellow Pages. Write the list on the chalkboard, and have a student check the list against the phone book. Look for categories that include individual names.

Ask students the following questions:

- Is there the same number of men and women in most occupations?

- Are secretaries and carpenters listed in the yellow pages?

- What do you find when you look up electrician?

- Does the list of gardeners include the names of many individuals?

When the list is complete (see occupation list on previous page), assign each pair of students an occupation from the chalkboard. Write each pair's occupation on the "Chart of Classified Occupations". (You may want to reproduce this chart on the board, or use an overhead projector.) Ask students the following:

- Which occupation do you think will have the most names?

Have the students estimate what percent of the people in each occupation are male and what percent are female. Let the pair that has the occupation make the estimate.

- Are there more men or women in this category?

- Have you ever seen a woman doing this job? a man?

Record the estimates on the chart. Enter the estimates for females in column 4 and the estimates for males in column 7.

- Do the male and female percentages for each occupation add up to 100%?

Distribute the phone books and tally sheets. Be sure estimates are made before phone books are passed out. Discuss tallying with students, if necessary.

- What does a tally show?

- Who uses tallies in real life?

Tally part of a list with the class to make sure the instructions are clear. Arrive at rules for including or excluding any given name. An overhead projection of a phone book page may be helpful.

- Is "Leslie" a man's name or a woman's name?

- Are "Marion" and "Marian" the same?

- What about an initial?

- Do we need to keep a record of names we don't use?
- Do we need a total count?

Have the students locate their occupation in the phone book. One student can read the names while the second student marks on the tally sheet.

When tallying is complete, ask students to compute percents on the tally sheet, following the instructions given.

After you and your students have entered information from the tally sheets onto the classified chart, review the results.

- Were estimates close to actual figures?

Make a graph of the occupations, showing male and female percentages. There are many ways to present this information in graphic form. Depending on student experience, allow students to create their own graphs, or you may have them complete the bar graph on the following pages.

After the graphs have been completed, discuss the meaning of the graph in relation to the statistics.

Variation

Instead of using the Yellow Pages for this activity, you may use directories from professional societies or state registries (for example, engineering directories). Also, city directories are a possibility, as well as university phone books (to see which subject areas contain the most male and female professors).

Worksheet

Tally Sheet

Date ______________________ Occupation ______________________

Student names ______________________ ______________________

Source of information ______________________

Tally of Female Names	*Tally of Male Names*

Summary		*Enter on the "Chart of Classified Occupations"*
Total number of tallies, male and female	______	Enter tally total in column 2
Number of names identified as female	______	Enter in column 3
Percent of names identified as female	______%	Enter in column 5
Number of names identified as male	______	Enter in column 6
Percent of names identified as male	______%	Enter in column 8

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Worksheet

Chart of Classified Occupations

Location ______________________________

Occupation 1	Total Count 2	Female			Male		
		Tally Count 3	Est. % 4	Local % 5	Tally Count 6	Est. % 7	Local % 8

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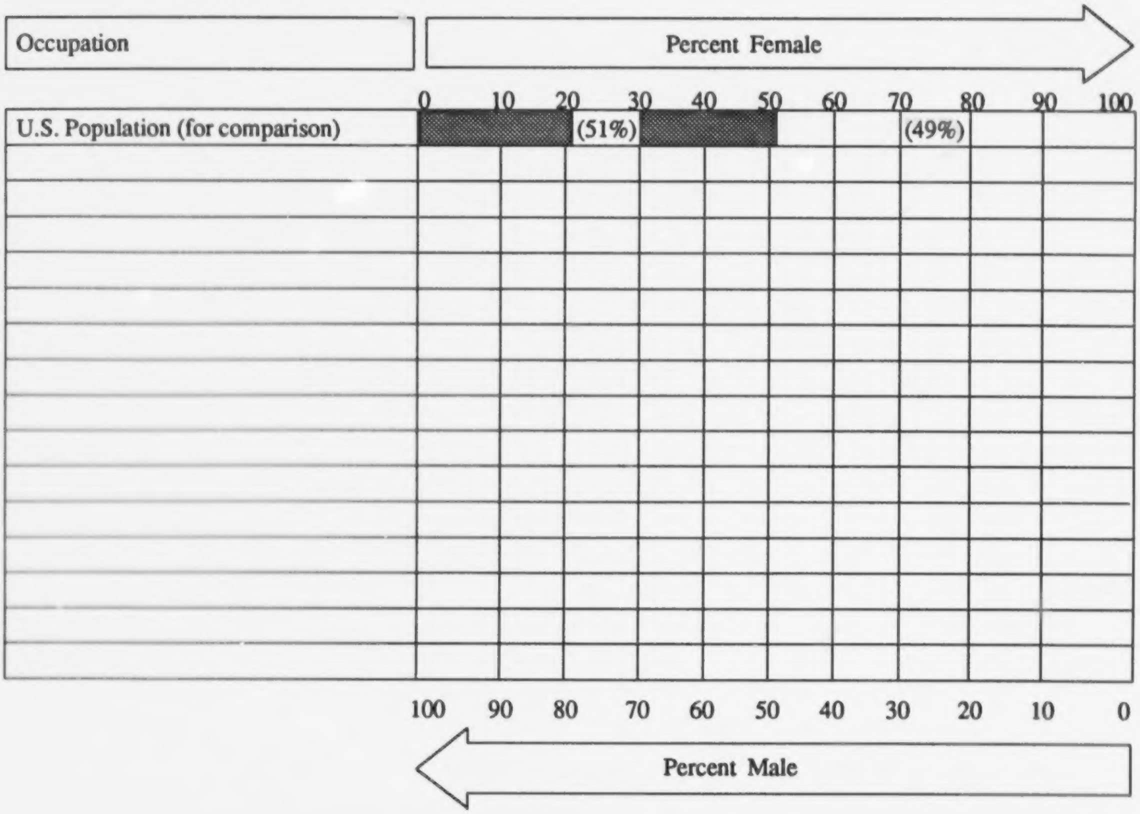
Worksheet

Graph of Yellow Page Occupations



Directions: Write the name of the occupation in the left column. Make a line on the bar space under the number that represents the percent of females (numbers at the top of the chart) in this occupation. Color the bar space from zero to that line with crayon, colored pen, or pencil. Color the rest of the bar space another color. The second color represents the percent of males in this occupation. (Read the percent from the bottom of the chart.)

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Resources

American Institutes for Research. 1980. *Programs to combat stereotyping in career choice.* Palo Alto, CA: American Institutes for Research.

In this book, sex stereotyping in career choice is discussed, and nine programs designed to expand students' career awareness and break stereotypical patterns are described. Many of the programs are suitable or modifiable for upper elementary students.

Askew, J. 1982. *The sky's the limit in math-related careers.* Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

This interesting book describes contemporary women in highly math-related occupations. Each of the chapters—computers, engineering, finance, math education, research mathematics, and statistics—includes several pictures and quotes from women about their jobs and the satisfaction they receive from them. Content is suitable for upper elementary students.

Downie, D.; Slesnick, T.; and Stenmark, J. K. 1981. *Math for girls and other problem solvers.* Berkeley: University of California, Math/Science Network.

The activities in this book encourage independent thinking and creativity in mathematics. Students and teachers are encouraged to think about problem solving in versatile ways and forms. Although this book was originally designed for females, the activities are appropriate and interesting to both boys and girls, ages 7–14.

Erickson, T. 1986. *Off and running: The computer off-line activities book.* Berkeley: University of California, Lawrence Hall of Science.

Off and running was developed to encourage minority and female interest in computers, math-based fields of study, and math-related careers. The content of the book includes on-line and off-line activities that teach computer concepts and skills. Activity themes focus on learning programing skills, cooperative learning, and equity in computer usage. This book has coupled excellent educational materials with strategies to promote equity. Content is suitable for grades 5–12.

Fraser, S., ed. 1982. *SPACES: Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are designed for students in grades 4–10.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assist educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. Ultimately, the purpose of the program is to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices.

An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction. Materials are suitable for grades 4–12.

Koltnow, J. 1980. *Expanding your horizons in science and mathematics*. Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

This booklet is a guide to planning and conducting conferences on math/science careers for girls. The conference format includes talks by role models and hands-on math and science activities for the girls attending.

Kreinberg, N., ed. 1977. *I'm madly in love with electricity and other comments about their work by women in science and engineering*. Berkeley: University of California, Lawrence Hall of Science.

This interesting and inspiring book includes selected comments about their work from women scientists, engineers, and mathematicians. Comments are organized into sections about careers in math, engineering, physics, astronomy, chemistry, and life sciences. Suitable for upper elementary students.

Massialas, B. 1983. *Fair Play: Developing self-concept and decision-making skills in the middle school: Decisions about mathematics* (Student guide). Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

Decisions about mathematics includes many real-life activities to interest middle school students and to promote math-related careers. Activities are organized around the topics of "math and money," "collecting and analyzing data," and "your future."

Mitchell, J. S. 1982. *I can be anything: A career book for women*. New York: College Entrance Examination Board.

This book provides specific information on a number of math, science, technical, and nontraditional blue collar jobs. Each entry includes a description of the work, educational requirements, information about women in the field, economic outlook, and sources of further information.

Saunders, H. 1981. *When are we ever gonna have to use this?* Chart. Palo Alto, CA: Dale Seymour Publications.

If you want a quick answer for the students' proverbial question "When are we ever gonna have to use this?", order this attractively done wall poster. The chart gives students information on just which careers require knowledge of specific math concepts. The chart can also be useful for developing your own math-in-careers activities.

Saunders, H. 1980. "When are we ever gonna have to use this?" *Mathematics Teacher* 73, no. 1: 7–16.

An interesting article relating Saunders's findings on the use of specific math processes and concepts in 100 different occupations. The article also contains a selection of word problems based on the occupational uses of math. Although many of the problems are too difficult for elementary students, they can provide ideas for developing your own occupation-related problems.

Wiggan, L., ed. n.d. *Dropping math? Say goodbye to 82 jobs*. Chart. Canada: Toronto Board of Education, Mathematics Department.

A brightly colored 18" x 24" poster that displays, in graphic form, each level (in the Canadian school system) of mathematics required for 82 jobs. You can easily relate the levels to those in the United States. The poster is suitable for students in grades 5–12.

Providing Positive Role Models for Girls

In addition to "book learning," one of the significant ways we learn is by watching and emulating the behavior of role models. Boys and girls see their parents, teachers, and other adults as role models of appropriate adult behavior. If female children are only exposed to women in traditionally feminine careers, they will "learn" that nontraditional careers are not appropriate for them. Many girls rarely see women functioning in technical and highly math-related careers. To increase girls' awareness of all their options, we need to make a special attempt to provide female role models who enjoy and are using mathematics in their everyday lives and careers.

- Exposure to salient role models is extremely important in determining girls' career choices. Female enrollment in undergraduate majors paralleled the proportions of female teachers within a discipline. (Fox 1981)

- In school, students see male teachers as role models in mathematics; in 1983, 83 percent of high school math and science teachers were male (Jones and Montenegro 1982). The more advanced a math course is, the more likely it is to be taught by a male teacher. (Fox 1981)

- Female elementary preservice teachers have lower estimates of their math ability and feel less comfortable teaching math than their male peers. (Aiken, cited in Stage et al. 1985)

- Among girls who had taken four years of high school mathematics, girls with 50 percent or more female high school math teachers chose careers that were significantly higher in math-relatedness than did girls who had experienced fewer female math teachers. (Franklin, Small, and Loesch-Griffin 1988)

- Both mothers and fathers of high math-achieving high school girls held jobs that were more highly math related than parents of high verbal/low math-achieving girls. (Franklin and Wong 1987)

- Adult females are less likely than males to engage in math activities and more likely to express doubts about their math abilities. Fathers are more likely to help their children with math homework than are mothers; mothers generally hold a more negative view of their own mathematics abilities and interests than do fathers. (Franklin and Wong 1987)

- Television programs (and movies) typically present females in traditional sex roles. We rarely see an attractive woman in a highly scientific or math-related career. (Fox 1981)

- Reading about successful women causes girls to have higher expectations of success and to spend more time on school tasks. (Campbell 1984)

These findings indicate that appropriate role models for girls are definitely underrepresented in society today, and this lack of role models could discourage some girls from engaging in mathematics-related activities and choosing math-related careers. To counter stereotypical views held by males, it is very important that boys also be exposed to females in math-related roles. Parental attitudes are also a very important factor in this area. Some ideas for working with parents can be found in the "Mathematics Promotion" section of this guide. The suggestions on the following pages will help you devise ways of providing role models appropriate for elementary-level girls and boys.

Strategies

1. Prepare a bulletin board (or have students do it) of women who are mathematicians or scientists and successful in their professions. Be sure to discuss it and place it on a prominent wall. To reinforce students' attention to the board, let them know that you will add a question or two about the material to an upcoming test.

2. An excellent strategy is to invite female guest speakers to visit the class and talk about how they use math in their careers. If you don't know where to find such women, use professional directories (of engineers, accountants, etc.), and/or contact your local university and the equity director of your state department of education. Student contact with role models involved in math and science careers (especially female role models) is very important, but preinterview guest speakers to ensure that they will communicate positively and effectively to children. Help your guest use vocabulary and definitions that your students will understand.

3. Mentors for individual fifth and sixth grade students (especially girls) can encourage more technical career choices. Use mentors contacted through such service clubs as Soroptimist, Toastmasters, and university speakers bureaus. Invite students of both sexes to after-school visits at the mentors' workplaces.

4. If you employ strategy 3 above, you may also be interested in getting together with other teachers to organize a community math support group that would include potential role models, people who would give tours, those who would sponsor internships or serve as mentors, and those who would help with math contests. This could become your school's Math Booster Club.

5. Use the stories on the following pages about real-life women working in math-related careers to interest your students in math and to provide role models. Encourage students to read and write stories about such women. The resource list also contains publications that include stories about famous women mathematicians and scientists. These stories help eliminate stereotypes (i.e., students will learn that a woman really can be the first person to create a new branch of mathematics or devise a unique approach to a problem); however, the women in these stories are often pictured as rather solitary persons who overcame great difficulties in order to "make it" in a male-dominated world of mathematics. If you do use the stories, it is important that you counterbalance them with readings about women who hold challenging high-level math or science-related careers while maintaining friends, family, and a wide variety of outside interests. It is very important that girls learn they don't have to be "outstanding math stars" or give up families and other activities in order to be scientists or mathematicians.

6. Discuss role models for girls and women, as presented in the popular media, with your students. Point out how these portrayals may be biased, and help students find other models that present a more balanced picture of women's roles.

7. Have students interview their parents and write brief papers about how their parents use math in their occupations. Select an example to share with the class.

8. Elementary students also look to junior high and high school students as role models. Ask other teachers to select some good, confident male and female math students to make a brief presentation to your class about the math they are studying and how they plan to use it in the future. Female college students can also be used to model math-related careers by presenting brief discussions about their studies and future careers to upper elementary girls.

9. Female teachers can serve as powerful role models for girls. If you are female, let your students see you enjoying and doing well in math. If you are a male teacher, make sure your students are exposed to female elementary teachers who are competent in and comfortable with math. You might consider team teaching math with a female colleague.

10. Encourage a "math is fun and useful for everyone" attitude. Try to project a feeling of confidence, interest, and enthusiasm about math to your students. If you feel uncomfortable, or think your math skills are inadequate, take some courses and/or work with other teachers until you feel confident about your skills.

Activity

Stories about Real Women

Objective	To provide students with information about actual female role models who are involved in nontraditional highly math- and science-related careers
Grade Level	Grades 4–6 (These stories may also be used with younger children; however, the vocabulary may need to be modified.)
Time	10 minutes per story, plus discussion time
Materials	Stories on the following pages (Includes "Geri Is a Nuclear Physicist," "Patti Is an Atmospheric Scientist," "Terry Is a Biochemist," "Carol Is a Computer Scientist," "Diana Is a Soil Scientist," and "Jenny Is a High School Math Teacher." These stories were developed by interviewing the women described; their real first names were used in the stories.)
Procedure	Read the stories (a single story per period), and conduct a brief discussion. Ask girls and boys why they would/would not like to have a career like the one described in the story. These stories may also be used in conjunction with science activities.
Variation	Invite a woman involved in a similar career to speak to the class after piquing their interest with the story. Let students write their own stories about these visitors. Another variation would be to have students make up story problems using the women described in the stories as the central problem-solving characters.

Handout

Geri Is a Nuclear Physicist

Geri is a nuclear physicist who works for a large company that manufactures rockets. She designs motors for the rockets. She spends some days making sure the motors are powerful enough to launch a rocket. A test of the rocket motor is called a "firing." While the physicists and engineers watch from a specially-built protective building, the rocket motor is started. The motor is fastened to the ground. Geri and the engineers measure its heat to see if it has enough power to launch the rocket. We call this power "propulsion." They also make sure the rocket's fuel lines are clear enough for the "propellant"—the rocket's special fuel—to go through.

Geri likes this work. She needs lots of math for her job. She was a good math student in elementary school, and when she was in high school she took math classes called algebra, geometry, and trigonometry. In college she took additional math and science classes. The science classes had names like chemistry, physics, and thermodynamics. All of these subjects were fun. She received a master's degree in nuclear physics from the University of Michigan; this helped her learn how to design rockets and mix different fuels for them.

In another part of her job, Geri uses a computer to look at the ways the motors fit all the other parts of the rockets. Sometimes she can see a new way to shape the rocket's nose so that it will fly faster. Sometimes she uses the computer to see how far the rocket will fly or to predict where it will land.

Like many other physicists, Geri is working on projects for the United States government. When her company is asked to design and manufacture new rockets, she meets with engineers to plan the best rockets possible.

When she is not at work, Geri likes to dance and go fishing with her husband and children.

Handout

Patti Is an Atmospheric Scientist

Patti's career is very challenging. She is an atmospheric scientist, and she works for a large center that does research on the environment. The gases that surround a planet are called its atmosphere. On our planet, Earth, the atmosphere is our air. The study of weather is one part of atmospheric science. Some atmospheric scientists study the gases around distant planets. Patti studies the Earth's atmosphere, and she is especially interested in studying clouds that produce snow. She studies the clouds that form over mountains in the winter to learn all she can about snow. Snow is very important to the water supply in the western part of the United States. Patti wants to understand why it snows, where it will snow, how much it will snow, and how to change snowfall patterns.

One exciting way Patti studies clouds is to fly an airplane with special equipment right through the clouds. Her airplane sends out a laser probe, a beam of light that can picture and record the amount of ice crystals in a cloud, to help her learn how much snow the cloud will make and how "wet" or "dry" the snow will be. Another way Patti studies clouds is by using something called radar. She puts a radar machine on the ground at the top of a mountain. The radar machine makes a picture of the cloud. From studying this picture, Patti can tell how high the cloud is and learn about the snow it will produce. Patti uses computers to help her analyze the data, or understand the information from the laser probe and the radar.

To learn her job, Patti needed to know a lot of math. She went to college and got a bachelor's degree in mathematics; then she took more classes to get a master's degree in atmospheric science.

Besides studying snow clouds, Patti likes sports. On weekends she loves to go wind surfing with her friends in the summer and skiing in the winter. She also likes to play with her dog, Dalby.

Handout

Terry Is a Biochemist

Terry's career is fun and interesting. She is a biochemist who does what's called "basic research" at a university. Chemistry is the study of the elements that substances contain and how substances can be changed. Biochemists study plants and animals and their life processes. In doing basic research, scientists study a thing or a process to understand how it works. Then other scientists use the information, or basic principles, they have learned and apply them to many other important areas.

All living cells are surrounded by membranes. These are thin materials that hold the cell together and yet allow some materials to enter and leave the cell. Terry studies the membranes of cells found in certain types of molds. One kind she studies is the mold that grows on oranges when they're left in the refrigerator; another kind is a fungus that grows in "humus" or decayed plant and animal material. Both of these are related to penicillin, a medicine we get from certain molds. Some of the molds that Terry studies prefer to grow at very high temperatures—even up to 150 degrees. Others, like the mold on oranges, prefer cold temperatures for growing. Terry grows her cells at different temperatures. Then she separates the cells using chemicals and measures their membranes to see what happened to them. These cells are so tiny they can only be seen with a powerful microscope. Terry's work is useful because by studying cell membranes in molds and how they react to different temperatures, scientists can learn many things about the cells in our own bodies and how they react to medicines and diseases.

Terry uses a great deal of mathematics in her research. She uses math to calculate the size changes in cell membranes. When she went to high school, Terry took all the math she could get. Calculus is a special branch of math that she needs to understand her results. Terry also uses computers to make graphs of what she has found and to help her analyze the data. Terry has three college degrees; she has a bachelor's degree in chemistry, a master's degree in biochemistry, and a doctorate in biochemistry. She also took many physics classes to prepare for her career.

In addition to her research, Terry teaches biochemistry to college students. Last summer some high school students worked with her in her laboratory. The students really liked being there and learning to do the research. After the summer was over, one of these girls said, "I never worked so hard or had so much fun." Another girl said, "I didn't know science was this much fun or this creative."

After working hours, Terry likes to spend time with her husband and five children. Her husband makes pottery, and Terry enjoys going with him to sell his pots at craft fairs. Other favorite things Terry likes to do are hiking, cross-country skiing, swimming, reading, and going to the theater—especially the ballet.

Handout

Carol Is a Computer Scientist

Carol is a computer scientist who writes programs for a very large company. Carol's job is fun and exciting because the programs she writes are used to run satellites—the large space vehicles we send to explore the planets in our solar system.

The computer program that tells the satellite where to go is called the "guidance system." The program allows people on earth, at the satellite command stations, to track the satellite at all times. It also lets them make changes in the vehicle's direction and speed and guide it to wherever it's supposed to go. Carol's programs are very carefully worked out. She tests them on a special computer to see if they are correct.

To make a satellite's program, Carol needs to know lots of mathematics. Math has always been fun for Carol. She likes it very much. When she was in high school and college, she studied all the math she could. After graduating from college, she took more courses and got a master's degree in applied mathematics and computer science. Applied mathematics is all about how you can use advanced math to solve problems and find the answers you need.

Besides her enjoyment of mathematics and working with computers, Carol has some hobbies. She loves sports and the out-of-doors. She likes to go hiking, swimming, scuba diving, and jogging with her friends. She also enjoys stitchery and reading. In a few months, Carol is going to get married. She is looking foward to next year when she will begin working on a program to guide satellites in exploring the planet Mars.

Handout

Diana Is a Soil Scientist

Diana has a "dirty job." She is a soil scientist. That means she studies dirt! Diana works at a university. She studies the soil around pine trees in a forest to discover all she can about it.

Pine trees need food, just like people. They get their food from the soil, or dirt. Diana is especially interested in the "fertility" of the soil; that is, she wants to find out how many foods for pine trees can be found in the soil.

Pine trees have needles instead of leaves. When a pine needle drops off a tree, it is full of foods for the tree. These foods go into the soil when the needle decays. The foods include many elements, such as nitrogen, iron, and phosphorus that help trees grow. Diana can't see these elements in the soil with her eyes. To find out what's in the soil, she has to collect samples of dirt from the forest and take them back to the laboratory. There she mixes chemicals into the soil and looks at the result. Through this process she can tell how many foods are in the soil. To make her job easier, she uses a computer to study the soil samples.

Diana's work is very important because it helps people decide where they can cut down trees for logs and how long it will take for new trees to grow in the forest. To become a soil scientist, Diana studied a great deal of math and chemistry in college. She always thought it was fun to learn these subjects. After graduating from college, she studied more and got a master's degree in soil science.

Although Diana really enjoys her job, she also likes to spend time with her family, especially water skiing and playing racket ball. She also has fun making pottery in her spare time.

Handout

Jenny Is a High School Math Teacher

Jenny loves to learn about mathematics and to help other people learn about it, too. She teaches math and computer programming at a large high school. Because she is a very good teacher, she was chosen to be the leader of all the math teachers at her school.

Jenny has been teaching math for ten years, and she has taught just about every kind of class you can take in mathematics and computers. In high school, the math classes are called algebra, geometry, trigonometry, and calculus. These subjects are fun to learn. Jenny's favorites are algebra, trigonometry, and advanced computer programming. In algebra, students learn to solve all kinds of problems in new and interesting ways. In trigonometry, which is called "trig" for short, they discuss how to use angles and shapes to solve problems. Both of these subjects are very useful in people's jobs. Advanced computer programing is also a very interesting subject that helps people in all kinds of careers. Jenny especially enjoys learning more about her own computer.

The thing that Jenny likes best about mathematics is the fun of using it to figure out how to solve a problem that she couldn't solve before. When you learn about arithmetic in grade school, it seems like mathematics is made up of a lot of rules that never change. But when you get to advanced mathematics in high school and college, you will see that people are still discovering new things about numbers and finding new answers to questions about math. Jenny also enjoys this "new discoveries" part of mathematics.

To become a mathematics teacher, Jenny studied all the math she could in high school and college. She got a bachelor's degree in mathematics and a master's degree in teaching.

Besides mathematics, Jenny has many other interests. She likes playing tennis and going on long walks with her husband. She also enjoys doing needlework and reading science fiction. One of her favorite pastimes is playing video games.

Resources

Askew, J. 1982. *The sky's the limit in math-related careers.* Newton MA: Women's Educational Equity Act Publishing Center/EDC.

This interesting book describes contemporary women in highly math-related occupations. Each of the chapters—computers, engineering, finance, math education, research mathematics, and statistics—includes several pictures and quotes from women about their jobs and the satisfaction they receive from them. Content is suitable for upper elementary students.

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Kreinberg, N., ed. 1977. *I'm madly in love with electricity and other comments about their work by women in science and engineering.* Berkeley: University of California, Lawrence Hall of Science.

This interesting and inspiring book includes selected comments about their work from women scientists, engineers, and mathematicians. Comments are organized into sections about careers in math, engineering, physics, astronomy, chemistry, and life sciences. Suitable for upper elementary students.

Osen, L. M. 1974. *Women in mathematics.* Cambridge: MIT Press.

This book was written to give students a historical perspective about women in math. Many myths about women in math are exposed, and women's aspirations for mathematical careers are encouraged. The material is suitable for students in grades 5–6.

Perl, T. H. 1978. *Math equals: Biographies of women mathematicians and related activities.* Menlo Park, CA: Addison-Wesley.

Math equals is a teacher resource on the history of women in math and science. The book contains biographies of the lives and work of nine famous women, plus math activities related to the area of mathematics in which each of the women worked. Most of the activities will probably be too difficult for students in grades K-6; however, many of the biographies

are suitable reading material for grades 5–6.

Perl, T. H.; Manning, J.; and Christner, P. 1981. *Women, numbers and dreams* (teacher's manual and activity workbook). Santa Rosa, CA: National Women's History Project.

This clearly written workbook includes biographical sketches of famous female mathematicians along with several mathematical activities appropriate for students in grades 3–6. Additional activities are suitable for more advanced students. The teacher's manual includes suggestions for incorporating these materials into the classroom and use of the stories as the basis for role-playing activities.

Part 3

The Learning Environment

This section of the guide contains suggestions that will help you

1. assess and increase your equitable teacher-student interaction patterns
2. encourage cooperative rather than competitive learning
3. implement an effort-persistence-mastery approach to problem solving
4. encourage independent thinking and creativity in learning mathematics

Increasing Equitable Teacher-Student Interaction Patterns

We know from the findings of many research studies that even though most teachers believe they are completely fair and nonbiased in their treatment of children in the classroom, major differences do exist in the way they interact with girls and boys. Teachers are almost always completely unaware that they may be treating girls and boys differently and that they may have different expectations for each gender. The results of these differential teacher treatments and expectations can lead to girls' performing at a lower level than boys.

- Teachers allow boys more time to answer questions (Gore and Roumagoux 1983), and they give boys more detailed explanations and feedback. (Webb 1981)

- Teachers are more likely to give extended directions to male students and to require them to complete a task or solve a problem; they tend to complete tasks or provide answers for females. (Sadker and Sadker 1985)

- Boys predominate in the classroom—they volunteer more answers, are likely to receive more teacher attention, both positive and negative, more praise, and more detailed instruction; even "aware" teachers fail to notice these differences. (Sadker and Sadker 1985; Morse and Handley 1982)

- Teachers seem to expect less of female students (Cartledge 1984), and they are less likely to recognize mathematical talent in girls than in boys. (Fox 1982)

- At all levels—from elementary to postsecondary—males receive more teacher interactions than females (Thomas 1983); high achieving high school boys receive significantly more attention in mathematics than any other group. (Good et al., cited in Fox et al. 1980)

- Teachers ask twice as many higher order questions of boys than of girls, and boys receive more feedback and more teacher-initiated help. (Cartledge 1984)

- Some teachers segregate students into single-sex groups; others do nothing to interfere when boys and girls segregate themselves—some even encourage this separation. (Grayson and Martin 1988)

- Students in gender-segregated groups often emphasize different values and roles. Girls value popularity and sweetness, while undervaluing academic performance; boys are more interested in being strong and performing well academically. (Fox, cited in Grayson and Martin 1988)

- Boys typically receive more criticism and stronger disciplinary action from teachers than do girls. (Grayson and Martin 1988)

- In selecting college majors, teachers' influence is more important for girls than for boys. (Ware and Lee 1985)

There are several reasons why even teachers with strong desires to treat all students fairly may inadvertently practice sex bias in the classroom. The rapid pace of interactions taking place during instruction makes it difficult for a teacher to attend to subtle classroom dynamics. Also, boys are much more assertive in school—they are eight times more likely to shout out answers and capture their teacher's attention. However, teachers often encourage this behavior—when boys shout out, teachers acknowledge them; but when girls shout out, teachers typically reprimand them and ask them to raise their hands if they want to be called on (Sadker and Sadker 1985). Research findings indicate that students do notice differences in the ways teachers treat members of each gender, and that this differential treatment can have subtle, although unintentional, negative consequences for girls (Grayson and Martin 1988). Teachers' attitudes, expectations, and treatment of students definitely affect students' confidence, aspirations, and other mathematics-related attitudes. The following activities, designed for teachers only, were developed to help you observe your own interaction patterns and give you some suggestions to help you modify them, where appropriate.

Taken together, the activities in the following section may seem redundant. There is a reason for this. The activities on the following pages are listed in order from general self-examination processes dealing with classroom organization and teacher attitudes to peer group observation of your actual teaching behaviors. We believe that most teachers may first want to go through a self-examination of their interaction patterns with students. After the initial evaluation, many may desire to see themselves through video and examine their interaction styles in more detail; others will want to obtain feedback from other teachers and to compare notes on problems in managing an equitable classroom. Completing this latter activity will probably require cooperation from your school principal. The activities should *never* be used in a judgmental evaluation context. Strategies that work follow some of the activities. Use the following activities as a guide to help you improve your interaction patterns.

Activity

Self-Examination of Teacher-Student Relationships in the Classroom

Objective	To help you begin to think about your typical relationship patterns with students
Grade Level	For teachers of all grades
Time	30–60 minutes
Materials	Questions below
Procedure	Keep a journal (or copy the following) to write down your observations of interactions with students. Answer the following questions:

1. Do you plan different activities or different roles within an activity for boys and for girls? How are they different?
2. Are the examples you use in classroom discussions or teaching situations mostly male or female? Do you stick with examples that show women and girls in traditional rather than nontraditional roles?
3. Whom do you ask to perform heavy chores in the classroom, males or females?
4. Whom do you ask to do secretarial chores and special tasks, males or females?
5. Do you define, up front, which behaviors are acceptable in your class and which are unacceptable? Are they the same for girls and boys?
6. What are your behavioral expectations for the girls in your class? Are these different from your expectations for the boys?
7. Do you display affection and displeasure in the same way toward girls and boys?
8. Do you censure girls and boys for different behaviors? What behaviors?
9. Do you punish girls and boys for different things? Do you punish them differently? How?
10. Do you reward boys and girls for different things? Do your methods of reward differ?

Activity

Teacher's Self-Evaluation of Nonsexist Behavior in the Classroom

Objective	To help you examine your classroom behavior in four areas related to equitable instruction, and help you identify possible unconscious sexist behaviors in dealing with students
Grade Level	For teachers of all grades
Time	30 minutes to 1 hour
Materials	"Teacher's Self-Evaluation of Nonsexist Behavior in the Math Classroom" checklist on the following pages

Procedure

It is important that this checklist be used as an exercise to stimulate personal growth and awareness and *not be used in a judgmental way.*

Rate yourself for each numbered item in the following four areas:

1. Teacher's behavior
2. Interactions with others
3. Instructional tasks
4. Extracurricular activities

At the end of each section, review your ratings and evaluate your overall performance by marking the continuum. After checking for areas of weakness as indicated by your ratings, state your specific goals for becoming more sex fair.

Worksheet

Teacher's Self-Evaluation of Nonsexist Behavior in the Math Classroom

Teacher's Behavior

	Always	Often	Sometimes	Never	N/A
1. *Attitude.* I take the idea of equality seriously; for example, I do not put down men or women or joke about their math abilities.	____	____	____	____	____
2. *Language.* I use nonsexist language; in other words, I do not refer to all scientists or mathematicians as "he" or all nurses or secretaries as "she."	____	____	____	____	____
3. *Generalizations.* I avoid generalizations that refer to sex stereotyping in math; for example, "You think like a woman" or "You solve problems like a man."	____	____	____	____	____
4. *Types of examples.* I use examples in my teaching showing both men and women with a wide range of feelings, interests, and career choices. I include examples of women in highly math-related career areas.	____	____	____	____	____
5. *Facts.* I display and use accurate factual knowledge about the current economic and legal status of women and men of all races.	____	____	____	____	____
6. *Supplementary materials used.* I supplement inadequate treatment of either sex in classroom materials by adding information or by discussing the accurate portrayal of people's roles.	____	____	____	____	____
7. *Comparisons.* I avoid comparison of students based on gender; for example, I would not say, "The girls are working harder than the boys."	____	____	____	____	____
8. *Equal attention.* I give equal attention to boys and girls; I do not show preference for one sex over the other.	____	____	____	____	____

This self-evaluation was adapted from *Gender/ethnic Expectations and Student Achievement: Teacher Handbook* by Dolores Grayson and Mary Martin. Copyright 1988 by GrayMill Foundation. Used by permission. This material, by E. I. Newcombe, originally appeared in the public domain in *Becoming Sex Fair* by M. Calabrese, published by the Women's Educational Equity Act Publishing Center/EDC.

	Always	Often	Sometimes	Never	N/A
9. *Discipline.* I discipline both sexes in the same way.	____	____	____	____	____
10. *Values.* I reinforce students' expression of values without regard to their sex, so that both boys and girls can express assertiveness and gentleness.	____	____	____	____	____
11. *Vocational interests.* I help students explore all vocational interests, not only those traditionally associated with their sex.	____	____	____	____	____
12. *Model.* I act as a model of nonsexist behavior by performing activities traditionally thought to be more easily done by the opposite sex; for example, if female, I run AV equipment, lift boxes, and express a strong interest in mathematics; if male, I perform clerical duties and dust shelves.	____	____	____	____	____
13. *Grades.* My mathematics grading patterns do not favor boys or girls, but reflect individual accomplishments.	____	____	____	____	____
14. *Encouragement.* I encourage girls as well as boys to excel in mathematics and to pursue math-related careers.	____	____	____	____	____
15. *Beliefs about math.* I hold nonstereotypical beliefs about gender and math; that is, I do not believe that math is more difficult for girls than for boys; I do not believe that math is more important for boys than for girls or that boys naturally do better at math and are more naturally interested in it.	____	____	____	____	____

Summary Rating

I model sex-fair behavior (actions and words) in the classroom. I convey to my students the importance of equality and the appropriateness for both sexes of a range of roles and interests.

Mark the continuum:

Basically sex fair	Need slight improvement	Need some improvement	Need much improvement

Consider how you rated yourself on teacher's behavior. List below specific goals for increasing sex-fair behavior.

- ____________________
- ____________________
- ____________________

Interactions with Others

	Always	Often	Sometimes	Never	N/A
16. *Academic performance.* I expect equal academic performance from boys and girls; that is, girls are not assumed to be better in verbal skills and boys superior in math and science.	____	____	____	____	____
17. *Student interests.* I recognize that children may have interests not traditionally associated with their sex; I do not expect girls to have typically feminine interests and boys typically masculine interests. I expect girls to be very interested in math.	____	____	____	____	____
18. *Classroom behavior.* I expect the same behavior from girls and boys; for example, I do not expect chivalrous behavior only from boys, tolerate language (slang, swearing) from boys that girls may not use, or require neatness from girls and not from boys.	____	____	____	____	____
19. *Expression of emotions.* I permit all children to show their emotions without regard to sex (within the limitation of classroom rules).	____	____	____	____	____
20. *Nonsexist behavior.* I require students of both sexes to treat each other as equals; for example, I encourage students to include others of both sexes in all activities, and I do not allow the sexist remarks of students to go continually unchallenged.	____	____	____	____	____

Summary Rating

I have the same academic and behavioral expectations for boys and girls; I acknowledge the acceptability of the same emotions and interests in boys and girls.

Mark the continuum:

____

Basically sex fair	Need slight improvement	Need some improvement	Need much improvement

Consider your ratings on interactions with others. List your specific goals for increasing sex-fair behavior.

- ____
- ____
- ____

Instructional Tasks

	Always	Often	Sometimes	Never	N/A
21. *Bulletin boards.* All visual materials in my classroom are nonsexist and nonracist, showing men and women in a variety of roles that reflect the many interests of boys and girls.	____	____	____	____	____
22. *Supplementary materials available.* When the treatment of either men or women is inadequate in a textbook, I have supplementary materials readily available to students; for example, reference books about significant women in history or science or family-living books that explain the role of a father.	____	____	____	____	____
23. *Dividing students.* I avoid dividing or grouping students on the basis of sex, for example, in lunch lines, in seating, or for academic or athletic competition.	____	____	____	____	____
24. *Activities and assignments.* I recommend all classroom activities to both boys and girls; for example, I suggest both boys and girls try a cooking or a woodworking project as an optional activity.	____	____	____	____	____
25. *Classroom duties.* I assign classroom chores and duties without regard to sex; for example, both boys and girls carry chairs, run AV equipment, take notes during classroom meetings, and water plants.	____	____	____	____	____

Summary Rating

I plan classroom activities so that gender is not a criterion for organization; the classroom environment gives girls and boys the same kind of educational experience.

Mark the continuum:

Basically sex fair	Need slight improvement	Need some improvement	Need much improvement

Consider how you rated yourself on instructional tasks. List your specific goals for increasing sex-fair behavior.

- ____________________
- ____________________
- ____________________

Extracurricular Activities

	Always	Often	Sometimes	Never	N/A
26. *Availability of facilities equipment, and clubs.* I make all school facilities, equipment, and clubs equally available to all students.	____	____	____	____	____
27. *Recognition of achievement.* I give equal attention to the extracurricular achievements of boys and girls; for example, I acknowledge the athletic achievement of both sexes.	____	____	____	____	____
28. *Service projects.* I suggest that both girls and boys work on service projects.	____	____	____	____	____
29. *Participation in extracurricular activities.* I encourage boys and girls to participate in all extracurricular activities; for example, sports, cheerleading, library club, stage crew, etc.	____	____	____	____	____
30. *Roles in extracurricular activities.* I encourage boys and girls to participate in a variety of roles within extracurricular activities, for example, committee head, hospitality committee, secretary, treasurer, president, etc.	____	____	____	____	____

Summary Rating

I give boys and girls equal recognition and encouragement in extracurricular activities.

Mark the continuum:

Basically sex fair	Need slight improvement	Need some improvement	Need much improvement

Consider your ratings on extracurricular activities. List your specific goals for increasing sex-fair behavior.

- ____________________
- ____________________
- ____________________

Activity

Assessing Your Active Teaching Attention Patterns

Objective	To make you aware of potential inequities in your active teaching attention to girls and boys in the classroom
Grade Level	For teachers of all grades
Time	10–20 minute observation period, plus 20–30 minutes for data summary
Materials	Assessment and summary sheets on the following pages, stopwatch
Procedure	Recreate the "Assesment Sheet" to make it a full page. Ask a colleague to observe your classes while you are questioning and giving directions to students. Fill in the assessment sheet for active teaching attention patterns. Then, using the data gathered, answer the questions on the summary page about your own active teaching attention patterns.
Variation	Have your class video- or audiotaped. Then playback the tape, and use the assessment sheet to evaluate your own teaching behavior.

Strategies to Improve Active Teaching Attention

1. Circulate around the room after math assignment has begun. Position yourself in different areas to influence the degree of involvement of both girls and boys.
2. Make a conscious effort to encourage equal participation of girls and boys in math.
3. Distribute both lower order and higher order questions to girls and boys on an equitable basis.
4. Measure your wait time to insure an equal distribution for girls and boys.
5. Distribute the same types of reinforcement to both boys and girls.
6. Give extended directions to girls and boys on an equitable basis; provide extensive directions so girls and boys can complete tasks independently, and avoid doing or completing tasks for students.

Items 1–6 were adapted from *Sex equity handbook for schools* by Myra and David Sadker. Copyright 1980 by Myra and David Sadker, American University, Washington, D.C. Used by permission.

Some Ways to Keep Track of Your Questioning Patterns

1. Use a student-kept checklist of questioning patterns. Each day for a week have a *different* student keep a tally of which students are called on to answer questions.

2. Have copies of your classroom seating chart nearby when giving a lesson. Place a check next to each student called on to answer a question.

3. Students in front get called on the most. Rearrange your seating frequently, and move around. Ask questions from different parts of the room. Stand near those students who don't speak up in class.

4. Have every student's name on a 3" x 5" card. Shuffle the "deck," and draw to select students to answer questions.

5. Give every student a card with a distinguishable front and back. Each student who is called on turns over his or her card. Each student who is given a second response opportunity turns in her or his card. At the end of the period, check to see how many students still have cards upright, how many are turned over, and how many have been turned in. Is there a pattern?

Worksheet

Assessment Sheet: Focus on Active Teaching Attention

Record examples of classroom interactions involving teacher questioning and student response. In column 1: Teacher Question, check whether the question was a higher order question (HOQ) or a lower order question (LOQ). A higher order question is defined as one that requires the student to integrate material or to use a more complex mental process; a lower order question can be answered with simple recall. In column 2: Wait Time, measure the length of time given to male and female students to answer each question. Count the time the teacher pauses before providing hints or going to another student. In column 3: Student Responding, indicate whether a girl or boy answered the question. In column 4: Teacher Reaction, indicate the teacher's reaction to the student's response (e.g., praise, criticism, ignoring, a simple "OK," and so on). Try to fill in at least 25 interactions. Also, look for examples where the teacher gives directions to students, and note the completeness of the instructions, sex of the student, and whether or not the teacher completes tasks for students of each sex.

(1) Teacher Question		(2) Wait Time	(3) Student Responding		(4) Teacher Reaction
HOQ	LOQ		Girl	Boy	

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Examples of teacher's directions to girls and boys:

Worksheet

Summary of Information on Active Teaching Attention

	Frequently	Sometimes	Never
1. As a result of the data gathered in the chart, what are your conclusions on the following questions:			
a. Do you ask an equitable number of LOQs of female and male students?	______	______	______
b. Do you ask an equitable number of HOQs of male and female students?	______	______	______
c. Do you reinforce female and male students on an equitable basis?	______	______	______
d. Do you give an equitable amount of wait time to female and male students?	______	______	______
2. Do you give extended directions to both boys and girls on an equitable basis so that they can complete tasks independently? Examples:	______	______	______
3. Do you complete tasks for girls and boys instead of instructing so they may complete work independently? Examples:	______	______	______

4. What other strategies do/could you use to attain sex equity in active teaching attention?
Examples and comment:

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Activity

Assessing the Extent of Sex Segregation in Your Classroom

Objective	To make you aware of (1) the ways that students may be segregated in your classroom and (2) who initiates this pattern, i.e., teacher, students, or others
Grade Level	For teachers of all grades
Time	Four 5-minute observation periods, plus 20–30 minutes for data summary
Materials	Assessment and summary sheets on the following pages
Procedure	Ask a colleague to observe your classes and fill in the assessment sheet focusing on sex-segregation patterns. Then, using the information gathered, answer the questions about your own classroom on the summary page.
Variation	Have your class video- or audiotaped. Then playback the tape, and use the assessment sheet to evaluate your own classroom.

Strategies for Encouraging Better Integration in the Classroom

1. When seating or lining up students, use categories other than sex to divide the class (see resource list at the end of this section for suggestions). For example, you might seat alphabetically, rotating this seating periodically to give all students a chance to sit in the front of the room. You might line up by age (those over or under a certain age for two lines), color worn, or month of birth, etc.
2. Avoid sex-segregated play areas.
3. When students self-segregate in their own activities, it may be necessary to form a new organizational pattern to achieve classroom integration.
4. Encourage girls and boys to participate in traditional and nontraditional activities. For example, encourage girls to play with typically male toys such as construction blocks, tools, etc., and to be active in typically male sports and games. Encourage boys to play with typically female toys and to be active in typically female sports and games.
5. If students are uncomfortable with nonstereotyped assignments, discuss the issue of sex stereotyping and today's changing roles for women and men.

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6. Make a conscious effort to assign leadership and support roles to both boys and girls.
7. Encourage and reinforce girls and boys who are working and playing cooperatively.

Worksheet

Assessment Sheet: Focus on Sex Segregation

Record examples of sex segregation and integration in the classroom. In column 1: Sex Segregated/Integrated, indicate whether each area is segregated or integrated on the basis of sex. In column 2: Source, check the source that initiated each organizational pattern—the teacher, the student, or other (e.g., school policy, ability grouping, and so on). In column 3: Examples, give specific examples for each organizational pattern (e.g., seating charts, descriptions of segregated or integrated lines and groups, and so on).

Classroom Organization	(1) Sex Segregated/ Integrated	(2) Source	(3) Examples
Seating patterns		teacher ___ student ___ other ___	
Lining up procedures		teacher ___ student ___ other ___	
Work/play groups		teacher ___ student ___ other ___	

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Worksheet

Summary of Information on Classroom Sex Segregation Patterns

	Frequently	Sometimes	Never
1. As a result of the data gathered in the chart, what areas of classroom organization (seating, lining up, group work) need further work to promote sex integration? Give examples:			
2. Are "helping" tasks stereotyped on the basis of sex? (Examples: boys carry books, girls collect lunch money.) Examples:	______	______	______
3. If and when sex segregation occurs, is there an intervention that encourages integrated work and play groupings? Examples:	______	______	______
4. Is there reinforcement for girls and boys who work together on classroom activities? Examples: "Mary and Jeff, you two did a fine job on your group report" or "Randy and Becky, you really helped your team win the game." Examples:	______	______	______
5. What other strategies do/could you use to attain sex integration in classroom organization and activities? Examples and comment:			

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Activity

Assessing Your Classroom Discipline Patterns

Objective	To make you aware of potential gender inequities in your classroom discipline patterns
Grade Level	For teachers of all grades
Time	20–30 minute observation period, plus 20 minutes for data summary
Materials	Assessment and summary sheet on the following pages
Procedure	Ask a colleague to observe your classes (or videotape your classes) and fill in the assessment sheet for classroom discipline patterns. Then, using the information gathered, answer the questions about your own classroom discipline patterns on the summary page.

Strategies for Eliminating Sex Bias in Classroom Discipline

1. Avoid stereotyping girls as passive and obedient and boys as aggressive and disruptive.
2. Give reprimands according to the misbehavior and not on the basis of sex.
3. Relate penalties or punishments to the infraction; don't apply on the basis of sex.

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Worksheet

Assessment Sheet: Focus on Classroom Discipline Patterns

Record examples of student misbehavior and teacher disciplinary reaction. In column 1: Sex of Student, list the sex of the student involved in inappropriate classroom behavior. In column 2: Student Misbehavior, describe the type of misconduct (e.g., talking, leaving seat, and so on). In column 3: Reprimand, if given, indicate whether the teacher offered the rebuke in a harsh or soft, public or private manner. In column 4: Penalty, record the nature of any penalty assigned (e.g., detention, sent to office, and so on). In column 5: No Disciplinary Action, put a check mark if the teacher did not reprimand or penalize the student who was misbehaving.

(1) Sex of Student	(2) Student Misbehavior	(3) Reprimand	(4) Penalty	(5) No Disciplinary Action

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Worksheet

Summary of Information on Classroom Discipline

	Frequently	Sometimes	Never
1. As a result of the data gathered in the chart:			
a. Do you hold girls and boys to the same standards of classroom conduct? Examples and comment:	______	______	______
b. Do you dispense disciplinary action to boys and girls on a fair and equitable basis? Examples and comment:	______	______	______
2. Are equitable classroom management strategies used to avoid teacher-student confrontations that interrupt learning (e.g., nonverbal behaviors, proximity control, and so on)? Examples and comment:	______	______	______
3. What other management strategies do/could you use to avoid teacher-student confrontations and to attain sex equity in discipline for boys and girls? Examples and comment:			

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Activity

Assessing Your Classroom Verbal Evaluation Patterns

Objective	To make you aware of potential inequities in your verbal evaluation patterns
Grade Level	For teachers of all grades
Time	30-minute observation period, plus 20 minutes for data summary
Materials	Assessment and summary sheets on the following pages
Procedure	Ask a colleague to observe your class and fill in the assessment sheet for verbal evaluation patterns. Then, using the information gathered, answer the questions on the summary pages about your own verbal evaluation patterns.

Strategies for Ensuring Sex Fair Verbal Evaluation

1. Avoid stereotyping girls as excelling in neatness and boys as excelling in academic endeavors.

2. Distribute praise for academic work to girls and boys on a fair and equitable basis.

3. Identify both boys and girls whose academic work reflects neatness and conforms to rules of form.

4. Identify both girls and boys whose academic work reflects intellectual competence.

5. Offer remediation comments on verbal or written work that does not meet standards of form or intellectual quality to both girls and boys. Make sure students clearly understand the nature of the inadequacy and how to correct it. Encourage both boys and girls to try harder or to try another approach. Without this encouragement, students may think they do not have the ability and may simply give up.

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Worksheet

Assessment Sheet: Focus on Verbal Evaluation of Academic Work

Record all instances of teacher praise or criticism in response to student verbal or written academic work. In column 1: Sex of Student, list the sex of the student being praised or criticized. In column 2: Praise, check whether praise is given for the intellectual quality of the student's ideas and comments or for the correctness of form/appearance of the student's written work. In column 3: Criticism, check whether criticism is given for student ideas and comments that fail to meet standards of intellectual quality or for student written work that fails to meet standards of form, neatness and appearance.

(1)	(2)		(3)	
	Praise		Criticism	
Sex of Student	Student Ideas/Comments	Form/Appearance of Written Work	Student Ideas/Comments	Form/Appearance of Written Work

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Worksheet

Summary of Information on Verbal Evaluation Patterns

	Frequently	Sometimes	Never
1. Using the data gathered on the chart:			
a. Do you praise girls and boys on an equitable basis for the intellectual quality of their written and verbal work? Examples and comment:	______	______	______
b. Do you praise boys and girls on an equitable basis for the appearance, form, and neatness of their written work? Examples and comment:	______	______	______
c. Do you criticize girls and boys on an equitable basis concerning the intellectual quality of their written and verbal work? Examples and comment:	______	______	______
d. Do you criticize boys and girls on an equitable basis for written work that fails to meet standards for form, neatness, and appearance? Examples and comment:	______	______	______
2. Do you encourage both girls and boys to try harder so they will be more likely to attribute failure to insufficient effort rather than to lack of ability? Examples and comment:	______	______	______
3. What other strategies do/could you use to attain sex equity in the verbal evaluation of academic work? Examples and comment:			

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Activity

GESA—Gender/Ethnic Expectations and Student Achievement

Objective To provide you with specific feedback about your interaction patterns with students

Grade Level For teachers of all grades

Time Five 20-minute observation periods, plus 20 minutes for data summary for each period

Materials "GESA Observation Report" and "Coding Instructions" handouts below

Procedure GESA has found the following ten items to be the major areas of gender disparity in teaching:

Response opportunities
Acknowledgment/feedback
Wait time
Physical closeness
Touching
Reproof—verbal or nonverbal indication that a student's behavior is not acceptable
Probing
Listening
Higher level questioning
Analytical feedback

To identify these interactions, GESA designed the "GESA Observation Report" (see following pages). This form is meant to be used by one or more peer observers in your classroom. Any two of the ten areas listed above can be observed and coded at any given session. The report allows the observer to tally the occurrences of the two chosen interaction areas for the entire class of students. Instructions for filling out the form are included on the following pages. After an observation period, each teacher then analyzes the data from his or her classroom to determine any patterns of gender disparity. Teachers who have used the GESA training in their classrooms have noticeably decreased gender bias in teacher-student interactions. For further information about the GESA program and to arrange for GESA training, contact the GrayMill, RRI, Box 45, Earlham, IA 50072 (see resource list at the end of this section).

The GESA program is best carried out with training; however these materials have been included to show you what the program is like. Find one or more peers who also wish to take part in the program. You will take turns observing each others' class for a number of 30-minute periods (usually five or more).

Read the coding instructions that follow the form, and make sure that all observers agree on how responses will be coded. Make several copies of observation form. Label a and b the interactions you will be observing; for example, you might choose to observe "listening" and "probing." Write down students' names and prepare a class seating chart. You may code up to four observations for each interaction with a student.

All observation periods should be scheduled in advance, and all teachers should know which interactions are being observed. To facilitate the observation, teachers being observed should use students' names as much as possible.

To code the observation, make a slash mark by a student's name only when the teacher uses one of the strategies being observed.

Variation

You may wish to conduct a preliminary observation of each of the ten areas, then reobserve several weeks later.

Worksheet

GESA Observation Report

Interactions: a ______________ b ______________ Class ______________

Student No.	Sex	First Name	Eth.	Obs. 1		Obs. 2		Obs. 3		Obs. 4		TOTAL	
				a	b	a	b	a	b	a	b	a	b
01													
02													
03													
04													
05													
06													
07													
08													
09													
10													
11													
12													
13													
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35													
36													
37													
38													
39													
40													

Female - 1; Male - 2

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Handout

Coding Instructions

Coding Response Opportunities

The observer codes one response opportunity when the teacher calls on a student to answer a question, accepts the answer of a student who calls out a response to the teacher's question, or calls on a student to perform in some other way before the class or a small group. For example, the student could be asked to give an answer, work a problem on the board, give a report, or express an opinion.

Do not code response opportunities that are not part of the instructional process; e.g., "Are you cold, George?"

Coding Acknowledgment/Feedback

The observer codes acknowledgment or feedback when the teacher affirms, praises, corrects, criticizes, or rejects a student's response or performance. The key characteristic of feedback is that the student receives helpful information. The feedback says, in effect, you are on the right track or you need to make modifications.

Code only feedback that is clearly directed to one or several students—not to the entire class. Code only feedback that relates to the instructional task. Do not code feedback related to a student's posture, appearance, decorum, etc.

Coding Wait Time

Wait time is coded each time the teacher waits at least five seconds before terminating the response opportunity (usually by asking another student the same question) or providing additional information or hints.

Coding Physical Closeness

Nothing is coded if the teacher merely walks by a student. When the teacher stands or sits somewhere in the classroom physical closeness is recorded for each student within arm's reach.

If a student approaches the teacher and some instructional business is transacted within arm's reach, physical closeness is recorded. If the teacher remains near one or more students during the entire observation, physical closeness is recorded only once for each student. If the teacher leaves those students and later returns, physical closeness is recorded again. In other words, the initiation of the physical closeness is recorded, not the duration.

Coding Reproof

The observer records reproof when the teacher, unemotionally and respectfully, asks the student to stop behaving inappropriately. The student may or may not change the behavior. If the teacher later repeats the same request, a second reproof is recorded. Reproof may be nonverbal.

This material was adapted from *Gender/ethnic expectations and student achievement: Teacher handbook* by Dolores Grayson and Mary Martin. Copyright 1988 by GrayMill Foundation. Used by permission.

Coding Touching

Touching is recorded when the teacher's hand contacts the student in a way that expresses helpfulness, encouragement, regard, or affection. Touching is not recorded if the teacher touches the student angrily or to punish. Touching is not recorded if the teacher touches the student with a pencil, ruler, or other object, even if this is a friendly gesture.

Coding Probing

The observer records probing when the teacher provides additional information to assist a student who is having difficulty responding.

Coding Listening

The observer codes listening when the teacher's attention to a student's question, response, comment, and so on is apparent. Attentiveness may be indicated by the teacher's expression, gestures, or verbal response.

Coding Higher Level Questions

The observer records a higher level question when the teacher asks a question that requires a more complex mental process than simple recall. Everything that the teacher says to help the student understand the question is recorded as only one question.

Only those questions that are intended to be answered by students during the instructional period are recorded. Do not record hypothetical questions or questions that are part of homework assignments.

Coding Analytical Feedback

The observer records analytical feedback each time the teacher explains in a supportive way why a student's performance was or was not acceptable. The feedback must be helpful to the learning process. Feedback that does not deal with the learning content, but is directed at the student's attitude, appearance, or deportment is not recorded. If you cannot decide whether the feedback was positive and helpful, code nothing.

Activity

How to Reduce or Eliminate Sex-Role Socialization Effects

Objective

To help you think about steps you can take to counteract the effects of sex-role socialization

Grade Level

For teachers of all grades

Time

Variable

Materials

Questions listed below

Procedure

Some effects of sex-role stereotyping have been listed below. In the space provided, list some of the things you, as an educator, can do or say to reduce these effects on achievement.

Effect: Girls have fewer opportunities than boys to develop leadership skills.

How to reduce:

Effect: Boys are given more encouragement and rewards for achieving good math grades than girls.

How to reduce:

Effect: Boys tend to overestimate their level of math achievement; girls tend to underestimate theirs.

How to reduce:

Variation

Use this as a discussion activity with (a) other math teachers, (b) counselors, or (c) students.

Resources

American Institutes for Research. n.d. *We are what we play: How sex-typing affects your students.* Chart. Palo Alto, CA: American Institutes for Research, Center for Educational Equity.

A large wall chart describing the educational implications, especially for math and science learning, of boys' and girls' typical play patterns. The chart also includes suggestions for elementary classroom strategies that foster equity.

Campbell, P. B. 1986. "What's a nice girl like you doing in a math class?" *Phi Delta Kappan* 67, no. 7: 516–20.

This is an excellent summary article describing sex differences in mathematics achievement and career choices, differential treatment and expectations, and effective programs for promoting equity in math education.

deNys, M., and Wolfe, L. 1985. *PEER report: Learning her place—sex bias in the elementary school classroom.* Washington, DC: NOW Legal Defense and Education Fund.

An excellent summary with suggestions for remediating the effects of differential expectations and treatment of girls and boys. Designed for elementary teachers and parents.

Grayson, D., and Martin, M. 1988. *Gender/ethnic expectations and student achievement: Teacher handbook* Earlham, IA: GrayMill Foundation.

This manual accompanies the GESA training program. It contains a number of activities and exercises for teachers, plus explanatory information about the program.

Kaser, J. S. 1985. *Count me in! Guidelines for enhancing participation in mixed gender work groups.* Washington, DC: The Mid-Atlantic Center for Sex Equity.

This booklet includes guidelines for enhancing participation in mixed gender work groups. The suggestions can be very helpful for elementary educators, since much of the school day involves group interaction.

Mid-Atlantic Center for Sex Equity. n.d. *101 ways to line up.* Poster. Washington, DC: American University.

This poster suggests many ways that males and females may be lined up or grouped to enhance mixed gender interaction.

Sadker, M., and Sadker, D. 1980. *Sex equity handbook for schools.* Washington, DC: American University, Mid-Atlantic Center for Sex Equity.

This book reviews research on sexism in schools and provides hands-on classroom activities for teachers to counteract the effects of sexism in the classroom.

Encouraging Cooperative Learning

Our educational system was originally designed to meet the needs of male students. Many classroom activities and procedures emphasize competitive techniques, which have traditionally been thought to be more appropriate for the male learning style. However, recent studies have shown that most children learn more readily in cooperative situations. Competitiveness can interfere with learning because it (1) makes students anxious and interferes with their concentration, (2) doesn't permit them to share talents and learn from each other as easily, and (3) distracts them from what they are doing—they concentrate on the reward or on winning instead of on what they are learning. Evidence also indicates that girls learn more readily in cooperative situations that emphasize working with others and discussing how to solve problems.

- Of 109 studies conducted between 1924 and 1980 comparing competitive and cooperative learning, 60 percent found that students achieve higher levels when they work cooperatively as opposed to competitively. The reverse was true in only 7 percent, and no differences were found in one-third of the studies. The more complex the learning task, the worse children fared in a competitive environment. The superiority of cooperation was consistent for all academic subjects across all age groups. (Johnson, cited in Kohn 1986)

- In classes where boys and girls collaborate, sex stereotyping is reduced, girls display more positive self-esteem, and are more apt to assume leadership roles. (Campbell 1984)

- Girls are more likely to continue studying math when their math classes are interactive and instructive. (Stallings 1985)

- Many teachers have been taught to use competitive instructional strategies in the classroom. These can work to the disadvantage of female students who may feel more comfortable and perform at higher levels in cooperative situations. (*Concerns* 1985; Peterson and Fennema 1985)

- Academic work is rarely organized to encourage student collaboration, particularly cross-sex collaboration. In one study, only about 11 percent of instructional time was devoted to mixed-sex groups. (Lockheed, cited in Grayson and Martin 1988)

- The math achievement of fourth grade girls in both high- and low-level problem solving was found to be positively related to participation in cooperative mathematics activities, and negatively related to participation in competitive math activities. For boys, these relationships were reversed. (Peterson and Fennema 1985)

Although in testing situations, students still have to work on their own, the experience of cooperative learning has been shown in most cases to be a valuable one for both boys and girls. The ideas on the following pages include suggestions for incorporating cooperative activities in your classroom.

Strategies

The following are guidelines for creating a school environment that supports cooperative behavior:

1. Assign tasks on some basis other than gender. Every participant has resources useful to the group's problem-solving efforts.
2. Encourage females and males to sit next to each other.
3. Don't allow any single group member to dominate the group, activity, or the most desirable spaces in the group (e.g., head of the table).
4. Focus on the process of the cooperative activity. Recognize and share with students the results of cooperative efforts.
5. Expand the meaning of cooperation to include the whole school, families, neighborhoods, and workplaces.
6. Encourage students to study together—be aware of any learning group that forms naturally.
7. When leaders choose team members, make sure equal numbers of girls and boys are chosen for each team.
8. Possible barriers that sometimes hinder cooperative learning have been suggested by these research findings:
    a. Males are more likely to control discussion through introducing topics, interrupting, and talking more than females.

    b. Females talk less, often assume supportive rather than leadership roles in conversation, and receive less attention for their ideas from the group.

    c. Both males and females may expect group members to follow sex stereotypic roles that can limit each individual's contributions (e.g., males will be leaders, females will be secretaries).

Take action to overcame these potential barriers by:

a. Adhering to strict rules of class behavior, and using the same rules for boys and girls

b. Placing girls in leadership roles and monitoring their performance

c. Making students aware of stereotyping, expected roles, and how we are all free to choose and modify our roles

9. Some authors have suggested that if girls appear to have low confidence in their abilities, they need to be placed in single-sex groups to build confidence before joining mixed-sex groups.

10. Researchers have suggested several classroom cooperative techniques that can be adapted for teaching math. Some of these techniques are listed on the following pages. They include Math Teams Tournaments, Student Teams—Achievement Divisions, Jigsaw, and small group teaching. Use the resource list to find suggestions for additional ways to structure cooperative math learning activities.

Activity

Math Teams Tournaments (and other cooperative activities)

Objective

To allow students to experience cooperative learning; to learn and practice math skills

Grade Level

Grades 2–6

Time

Blocks of 30–45 minutes per session (may also be used as a free-time activity and/or a continuing activity)

Materials

Teacher-generated study materials, quiz questions for tournaments

Procedure

This technique combines elements of both cooperation (the teams) and competition (the tournaments). The primary function of the teams in this activity is to prepare members to do well in the tournament. First explain the procedure to students, letting them know how the teams will function, and that all teams have an equal chance of winning—it depends on how well they prepare.

Assign students to *heterogeneous* groups of four or five members. Each group should include females and males who vary in ability level and ethnic origin.

Instruct student teams to prepare for math tournaments that will be held once each week (or whenever you decide). Give students worksheets covering the academic material to be included in the tournament; teammates study together and quiz each other to make sure that all are prepared.

For the tournament, assign students to groups of three with *homogeneous ability* at each tournament table; assign the top three students in past performance to one table, the next three to another table, etc. For example, if your class had 30 students, you might have six 5-person teams and ten 3-person tournament tables. To avoid stigmatizing lower ability children, use various names for these tables, rather than numbers or letters. Also, don't automatically put the top students at the first table you assign and the lowest ability students at the last table you assign; assign a mid-level table first, then a lower ability table, etc.

Students at each table compete in simple math quizzes that cover content material that you have presented in class and on the study worksheets. You might, for example, quiz on math facts or problems and allow students to answer "Jeopardy" style, with the first right answer at a table earning a point, and an incorrect answer losing a point. Students compete as members of their teams, and the scores they earn at their tournament tables are added to make a total team score. Because students are assigned to ability-homogeneous competitive groups (the tournament tables), each student has an equal chance of contributing a maximum score to his or her team.

Following the competition, recognize successful teams and first place scorers at each tournament table. For future tournaments, members can remain on the same teams; however, you may have to change assignments to tournament tables to maintain equality of performance among each group of three students.

Variations

Student Teams—Achievement Divisions. In this variation, the same four to five member heterogeneous teams are used for studying math materials. Instead of competing in groups of three, however, have all students take a written 15-minute quiz. Compare scores of students within six student "achievement divisions," i.e., the top six students on past math performance would be in Division Yellow, the next six students would be in Division Green, and so on. Using this method, you will be comparing students within fairly homogeneous ability groups. Decide ahead of time how to assign points for division winners and runners-up. These scores contribute to an overall score for each original team. For example, the top scoring student in each achievement division might earn 10 points, the second student, 8 points, and so forth. For subsequent quizzes, change division assignments to maintain equality in the divisions, but leave students in their original teams. Again, recognize winning teams and individual winners and runners-ups in each division.

Jigsaw. In this variation, a student from each team focuses on learning and/or reviewing one particular skill or aspect of a problem solution. Members from different teams who are assigned to a particular topic or aspect study it together; then, each student teaches the material to their original teammates. All students take a quiz, and their scores are used individually or as contributions to team scores.

Small Group Teaching. In small group teaching, learning takes place through cooperative group inquiry, discussion, and data gathering by students. Students select subtopics within a general area selected by you—for example, salaries in different professions or occupations. Students then organize into small groups of two to six members and subdivide the topic into individual tasks to be performed by group members. Each group presents its findings to the class as a whole.

Activity

Cookie Store

Objective	To have students work cooperatively in teams to demonstrate their ability to make change, figure costs, reduce or increase amounts of ingredients in recipes; to allow students to practice computational skills and to give them a cooperative money-raising activity
Grade Level	Grades 3–6 (modify for grades 1–2 by omitting more complex aspects)
Time	1–2 class periods
Materials	Cookie ingredients and food preparation equipment, expense sheets
Procedure	Let students prepare cookies, figure costs, and be responsible for retailing the merchandise. Divide students into the following *mixed-gender groups:* planners, bakers, accountants, and sellers. The planners will be responsible for deciding what kinds of cookies to make and for figuring the amount of ingredients to be purchased. The bakers will be responsible for preparing the cookies, including reducing or increasing recipes. The accountants (grades 3–6 only) will figure the amounts to charge for the cookies and the "net profit or loss," and the sellers will collect the money from the cookie sales and make change.

Activity

Cooperative Geometry

Objective

To learn to solve problems cooperatively

Grade Level

Grades 4–6

Time

20 minutes

Materials

Square patterns on the following pages

Procedure

For each group, get four paper clips and one envelope. Duplicate the square pattern sheets. Cut out the four squares. Cut each square along the solid lines into four pieces. Clip together all the pieces marked A, all those marked B, and so forth. Put the four clipped-together bundles into an envelope. Also, cut out and give each student a square pattern outline.

Divide the class into groups of four, arranged at tables or at desks pushed together.

Rules: Explain these to the groups before you start.

- Each member of the group gets one clipped-together bundle of shapes.
- Each member of the group is trying to build a square.
- No one may take a shape from anyone else; the person with the shape must offer it to the person who needs it.
- The group is done only when all four member have completed their squares.

If this activity is too difficult for your students, let them see one or more completed shapes.

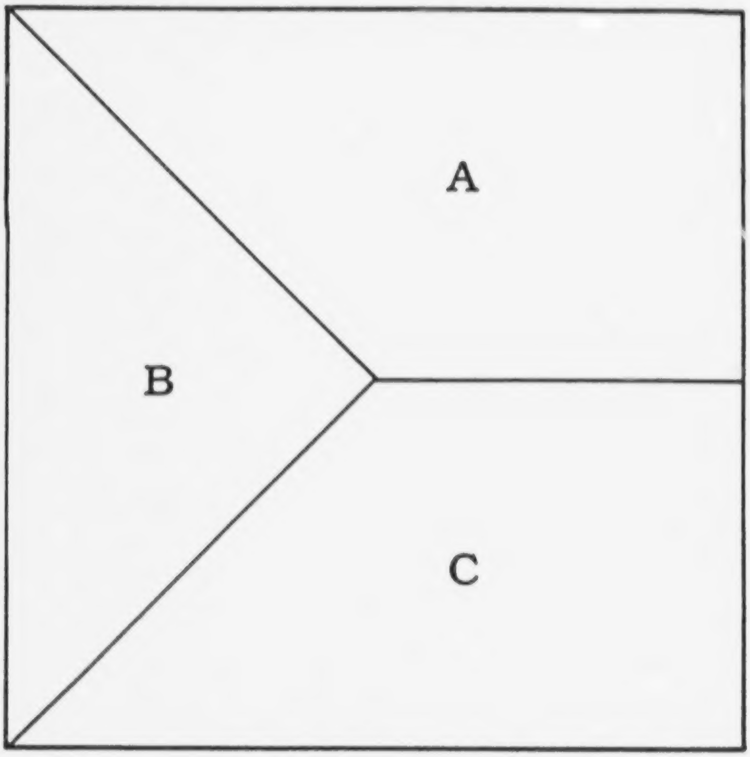
Variation

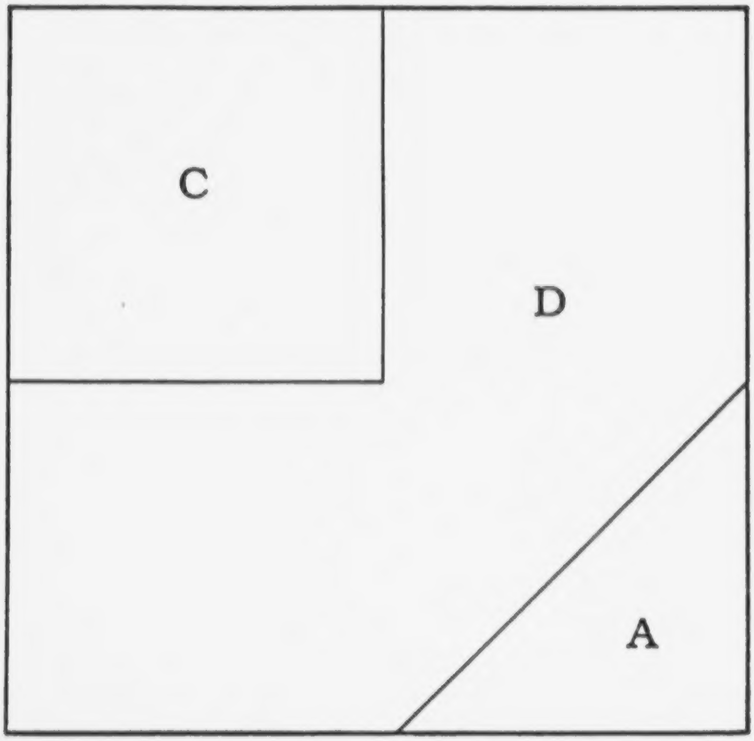
Let students design their own shape puzzles for the class to solve.

Adapted from *Off and running* by Tim Erickson. Copyright 1986 by The Regents of the Universtiy of California. Used by permission.

Handout

Square Patterns





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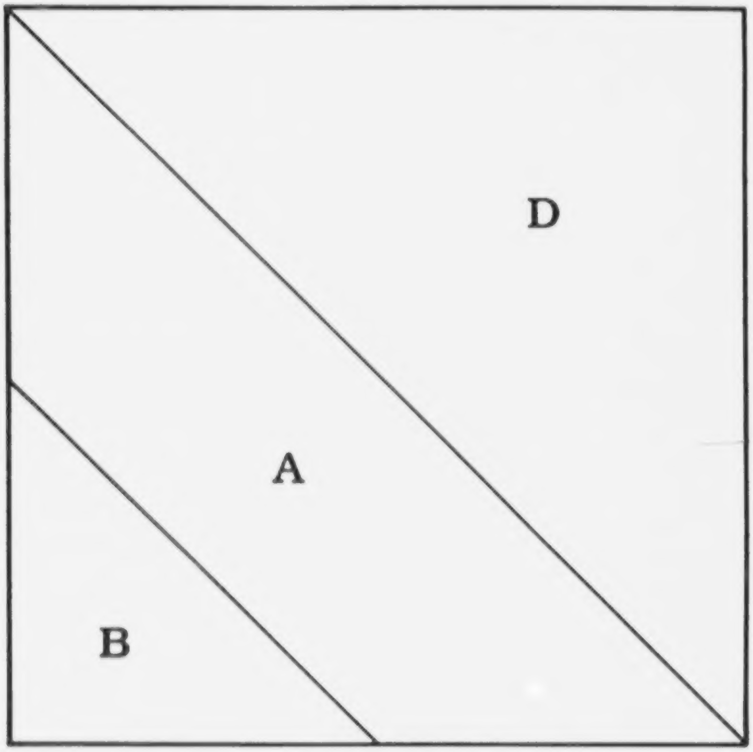
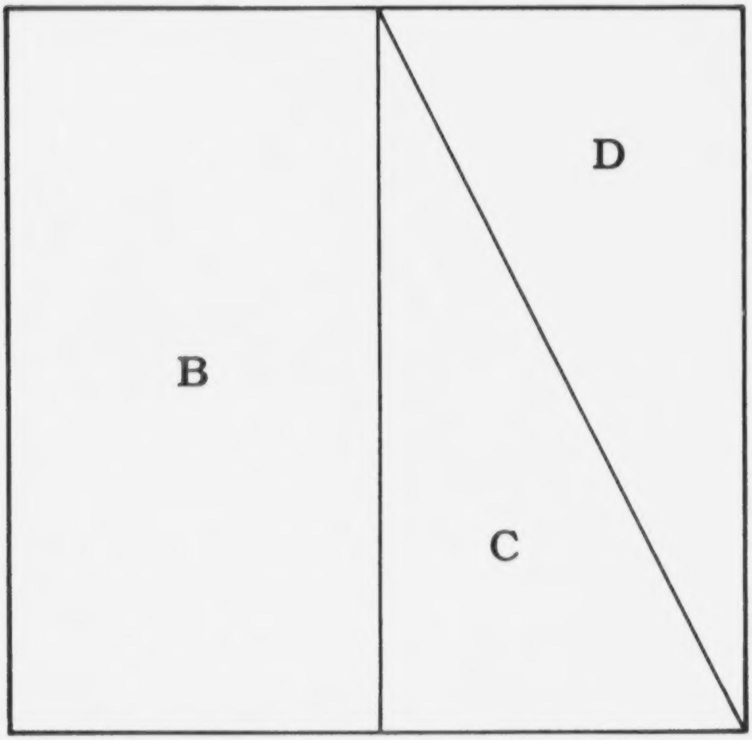
Handout

Square Patterns





Handout

Square Patterns

Activity

Cooperative Logic

Objective

To allow students to learn to solve problems cooperatively

Grade Level

Grades 4–6

Time

30 minutes

Materials

Sets of clue cards on the following pages, envelopes

Procedure

For each group, duplicate the "Clue Cards" sheet. Cut out the six cards on each sheet, and place them in an envelope. If there are going to be fewer than six people in the group, omit the card with the stars or let groups distribute "leftover" cards to the players so that some of them have two.

Divide the class into groups of four to six, arranged at tables or desks pushed together. After you've explained the rules, pass out one envelope to each group.

Rules: Explain these to the groups before you start.

- Distribute the clues among members of the group, one clue to each person.
- Each person may read her or his clue aloud, but may not show it to another player.
- Read the card with the number 1 on it first.
- The group is trying to solve a logic problem together.
- The group is done only when everyone agrees the problem is solved.

Answers:

Barbara, Michael, Peggy, Diane, Robert

Variation

Have students find or write additional simple logic problems and prepare clue cards for them. *Off and running* or *Get it together* by Erickson contains several good problems.

Adapted from *Off and running* by Tim Erickson. Copyright 1986 by The Regents of the University of California. Used by permission.

Handout

Clue Cards

Peggy will be 12 years old tomorrow.

Put the students in order from oldest to youngest.

Michael is 3 years older than Diane.

Put the students in order from oldest to youngest.

Diane is 9 years old.

Put the students in order from oldest to youngest.

Robert is 6 years younger than Peggy.

Put the students in order from oldest to youngest.

Barbara is 1 year older than Michael.

Put the students in order from oldest to youngest.

Peggy is the only one who has a birthday this month.

Put the students in order from oldest to youngest.

Resources

Clements, Z. J., and Hawkes, R. R. 1985. *Mastermind: Exercises in critical thinking, grades 4–6.* Palo Alto, CA: Scott, Foresman.

Mastermind activities are designed to foster the mathematical learning strategies of talented and gifted students in elementary school. The activities have been grouped according to Bloom's Taxonomy of Educational Objectives. The hierarchical organization of the book's contents enables educators to use the activities as supplemental material to develop new critical thinking skills and to reinforce previously learned mathematical skills.

Cook, M. *Math materials.* Catalog. Balboa Island, California.

These materials include tiling sets, task cards and books designed to add variety to math. The materials emphasize problem solving and focus on active student involvement. Also included are several books on cooperative learning. A catalog is available from Marcy Cook, P.O. Box 5840, Balboa Island, CA 92662.

DeRoche, E. F., and Bogenschild, E. G. 1977. *400 group games and activities for teaching math.* West Nyack, NY: Parker.

This book includes 400 classroom-tested math strategies and activities suitable for use in cooperative mathematics learning for elementary and junior high students. The activities are enjoyable and focus on the practical implications of learning math in a cooperative classroom atmosphere.

Erickson, T. 1989. *Get it together.* Berkeley: University of California, Lawrence Hall of Science.

This activity guide presents a collection of over 100 "six bit" logic problems designed to facilitate cooperative learning. The problems cover a wide range of subject matter and difficulty. Suitable for grades 4–12.

Erickson, T. 1986. *Off and running: The computer off-line activities book.* Berkeley: University of California, Lawrence Hall of Science.

Off and running was developed to encourage minority and female interest in computers, math-based fields of study, and math-related careers. The content of the book includes on-line and off-line activities that teach computer concepts and skills. Activity themes focus on learning programming skills, cooperative learning, and equity in computer usage. This book has coupled excellent educational materials with strategies to promote equity. Content is suitable for grades 5–12.

Kaser, J. S. 1985. *Count me in! Guidelines for enhancing participation in mixed gender work groups.* Washington, DC: The Mid-Atlantic Center for Sex Equity.

Most of the school day involves group interaction. This booklet offers elementary educators suggestions that enhance mixed-gender group participation.

Slavin, R. E. 1980. "Cooperative learning." *Review of Educational Research* 50, no. 2: 315–42.

This journal article summarizes the various methods of cooperative learning and the benefits for students who experience cooperative learning. A good basic reference on strengthening cooperative learning activities.

Stenmark, J. K.; Thompson, V.; and Cossey, R. 1986. *Family math.* Berkeley: University of California, Lawrence Hall of Science.

If mathematics promotion is a goal of your teaching, *Family math* activities will help you introduce parents and children to ideas that improve their math skills and help them gain an appreciation for math. Hands-on mathematical experiences provide families an opportunity to develop problem-solving skills by using the following strategies: looking for patterns, drawing pictures, working backwards, working cooperatively with a partner, and eliminating possibilities. Spatial relationships (geometry), estimation, data interpretation (probability and statistics), and mathematical reasoning are the mathematical concepts learned from *Family Math.* Materials suitable for ages 5–18.

Wiebe, A., and Hillen, J., eds. 1986. *AIMS Newsletter.* Fresno, CA: AIMS Education Foundation.

This newsletter describes the AIMS (Activities that Integrate Math and Science) program. The program includes a wide range of science and math activities and focuses on the integration of learning experiences, problem-solving activities, and cooperative learning.

Implementing an Effort-Persistence-Mastery Approach to Problem Solving

The goal of this approach is for students to become interested in learning for its own sake and that they strive to understand and improve their own performance rather than judge themselves against other students. In other words, for students to become intrinsically motivated. For a variety of reasons, including the ways teachers assist them, girls are more likely than boys to exhibit "learned helplessness"; i.e., the feeling that one is incapable of learning without assistance. As discussed in the section on attribution patterns, girls typically attribute failure to lack of ability, which often results in lack of persistence and lack of motivation to master mathematical concepts.

- Teachers typically encourage boys to figure out the answers to a problem; they are more likely to help girls by giving them the answers. (Sadker and Sadker 1985)

- Math teachers have been found to give different feedback to boys and girls for wrong answers—telling boys to try harder, while praising girls for "just trying"; this finding is consistent with the "learned helplessness" syndrome. (Fox 1981)

- Teachers contribute to "learned helplessness" in girls by praising them for intellectually irrelevant aspects of their responses, even when the responses themselves are incorrect (Russo 1985). Some examples: teachers often praise girls for the neatness of their work, even though it may be of poor academic quality; teachers often say to girls who failed, "That's okay, as long as you tried."

- In one study, it was found that girls were seldom criticized for the neatness and form of their work; about 90 percent of teacher criticism directed at girls focused on intellectual inadequacy of their work; only about 50 percent of criticism directed at boys focused on intellectual inadequacy. (Dweck, cited in Grayson and Martin 1988)

- In another experiment, boys were found to be more likely than girls to persist in difficult tasks in which they had failed. (Hughes et al. 1986)

- Several investigators have found that females are not as involved in problem solving activities as males. However, the belief that females are not as intrinsically motivated in mathematics as males has been refuted by results from many other studies. (Fox et al. 1980)

- Teachers' encouraging comments are very important, particularly for girls. Some researchers have theorized that boys appear to have an intrinsic mastery motivation, whereas girls' motivation is related to extrinsic need for approval. (Story and Sullivan 1986)

The suggestions on the following pages are designed to help you increase an effort-persistence-mastery approach to problem solving for all students, and especially for girls.

Strategies

1. In your mathematics instruction, include information for males and females about the importance and usefulness of math. Help students develop a desire to learn math for its own value, not because they "have to."

2. De-emphasize right and wrong answers. Give special attention to procedure, so students can identify their errors and focus on specific areas needing improvement to attain mastery. Students will be reassured of their ability to master mathematical skills if this approach is used.

3. Provide opportunities to increase problem-solving abilities. To expose students to problem solving, try the "two-problem approach." Each day at the beginning of the class, put two problems on the board for students to solve. Be sure to give students an opportunity to discuss their solutions and the merits to each approach in solving these problems.

4. Use guessing activities to help students develop estimating skills. Be careful not to reinforce wild guesses, but utilize wrong answers as a way of learning. Using probing questions can guide students to restructure their thought processes to appropriate responses. Such interaction will increase response opportunities and enhance self-concept—another area in which girls more than boys need assistance.

5. Ask students to state their problem-solving strategies, not just the answers. Focus on the use of appropriate methods and strategies rather than the "one right answer." Give students credit for using appropriate strategies. Explain that there is often more than one method to find the solution to a problem.

6. Use recreational and intuitive forms of mathematics. A technique to involve the whole class and to challenge students of all abilities is the use of "head" or oral problems. Head problems take a small amount of time and can be used to introduce new concepts and strengthen previous ones (see the first activity in this section for examples of head problems). If students' mathematical errors are due to lack of attention to detail, head problems should help remediate these types of errors. When possible, recreational mathematics should incorporate activities to strengthen spatial relationship skills for all students, especially the females.

7. According to Grayson and Martin (1988), the average time allowed by teachers for students to respond in class is 2.6 seconds. In mathematics classes, less response time is typically given to girls than to boys. Research suggests that this may be due to lower teacher expectations for girls in mathematics classes. Make sure you give all students an equal opportunity to answer. Don't answer for them or let girls "off the hook" too easily.

8. Encourage all students to figure out the answers to problems; don't give them the answers or do their work for them. Let girls know that their understanding is very important; it's not okay if they "just try."

9. When some students don't seem to understand, search for *alternative* ways to explain. Make sure that, if the class has to move on, those students who have not mastered the concepts aren't left in confusion. While they study the next topic, give them additional help and practice outside regular math classes until they catch up with the rest of the group.

10. Help students focus on what they've learned and understood, not just on grades. As much as possible, stress a concept mastery approach to math.

11. Make sure that all students understand that math is *not* a subject in which "either you catch on immediately" or "you don't catch on at all." Let them know that some topics in math are difficult, and that it takes persistence and practice to master math skills. Also let them know that even the top mathematicians in the world are working on problems they can't solve or understand yet. If you encountered *and overcame* difficulties in math, this is good information to pass along to your class.

12. Don't be so "kind" to girls that you let them get by without mastering basic mathematics. Often, girls are "good students," and teachers believe they are showing concern for them when they don't insist on concept mastery. Be really kind and concerned by being firm and insisting that no student get by without mastering all basic arithmetic skills. Students who have trouble with the basic concepts of mathematics in grade school will be at a tremendous disadvantage in future math classes.

13. Don't give in to girls' tears. Respond to the frustration, not to the tears. Try to help girls work through problems in a calm supportive way, without displaying undue solicitude or embarrassment.

Activity

Head Problems

Objective To motivate students to concentrate and follow problem steps

Grade Level Grades 2–6

Time Each problem takes one or two minutes (This is a great activity for "spare minutes" before the bell rings.)

Materials Suggested "head problems" below

Procedure Instruct students that you will be reading a problem aloud, and that they need to pay attention to every part of it and work it out in their heads. Read each problem aloud slowly. Make sure students are following along and are not using paper and pencils.

Variation You can make up many of these problems on the spur of the moment, or ask students to make up head problems. You can also use these types of problems to help students learn measurements, history facts, and so forth, while practicing computations. For students in higher grades, use fractions and decimals in problems. These problems and student-generated ones can also be put on cards and kept for future use. In this form the game is known as Crazy Cards.

Head Problems for Grades 2–3

1. Start with the number of days in a week; subtract the number of quarters in a dollar; add the number of toes on one foot. (Answer = 8)
2. Start with the number of cents in a dime; subtract the number of feet in a yard; subtract the number of eyes in your head. (Answer = 5)
3. Start with the number on the clock that comes after 12; add the number of cents in a nickel; subtract the number of legs on a dog. (Answer = 2)
4. Start with the number of sides on a square; add the number of cents in a penny; subtract the number of days you go to school every week. (Answer = 0)
5. If you had 3 tens and five ones, what number would you have? (Answer = 35)
6. If you had 2 hundreds, seven tens, and four ones, what number you would you have? (Answer = 274)

The idea for "head problems" was suggested by Tom Lester, San Juan Unified School District, Sacramento, California.

7. If you had nine ones and seven tens, what number would you have? (Answer = 79)

8. If you had four hundreds, three ones, and eight tens, what number would you have? (Answer = 483)

Head Problems for Grades 4–6

1. Start with the number of inches in a foot; divide by the number of legs on a horse; multiply by the number of days in a week; subtract the number of dimes in a dollar. (Answer = 11)

2. Start with the number of minutes in an hour; divide by three; add the number of sides on a triangle; add the number of years in a century; subtract the number of weeks in a year. (Answer = 71)

3. Start with the number of pounds in a ton; divide by 200; multiply by the number of sides in a rectangle; add the number of pints in a quart; subtract the number of weeks in half a year. (Answer = 16)

4. Start with the number of ounces in a pound; subtract the number that comes right before 14; multiply by the number of feet in a yard; divide by the number of tires on a bicycle. (Answer = 4 1/2)

5. Take the number 5; multiply by 2; add 4; subtract 7. What is the number? (Answer = 7)

6. Think of the number of months in a year; divide that number by 4; add 2; multiply by 5. (Answer = 25)

7. Think of the number of leaves on a "lucky" clover; add the number of years it took you to be 10 years old; divide by the number of days in a week. (Answer = 2)

8. Take the number of states in the United States; divide by 5; add the number of fingers on both hands; subtract 2. (Answer = 18)

9. Take the number that comes after 19; double it; divide by 8, and add 4. (Answer = 9)

10. Take the whole number that is greater than 7 and less than 9; add the digit that tells you how many hundreds there are in 1,582; subtract the number of things in a dozen. (Answer = l)

11. Take the number that makes the sentence __ x 5 = 20 true; add the number of cents in a dime; subtract the first odd number that comes after 6. (Answer = 7)

12. Take the number 20; add 300; add 7; add 4,000. What is the number? (Answer = 4,327)

Activity

Goal Setting and Watching Your Progress

Objective	To help students learn to set academic goals and to monitor their progress in math; to teach them that they earn their grades
Grade Level	Grades 4–6
Time	5–10 minutes per day
Materials	"Math Progress Sheet" (shown on the next page), folders, felt tip markers or crayons
Procedure	Learning to set and obtain goals may be one of the most important life skills you can teach to a child. Looking at grades or scores is one way to monitor academic performance. Provide a folder for each student. Staple a "Math Progress Sheet" into each folder, and have students fill in their name and the date. Ask students what grade they plan to obtain this grading period. Have them place that grade on the blank titled "First Grading Period Goal." Ask students to answer the question "What will I do to accomplish this goal?" For the first half of the grading period, give students weekly grades and test and/or quiz grades. Have students draw a line graph of their grades with felt tip pens or crayons. Have students keep important papers and tests or quizzes in the folder. At the midterm point, give students an update on their grade, or have students complete their own averages. Have students place that grade on the blank titled "Midterm Grade." Discuss with each student how she or he can obtain her or his goal, and praise students who are accomplishing their goals. These folders can also be used at parent conferences. It is helpful to parents to see their child's work and goals. At the beginning of each grading period, start fresh with a new "Math Progress Sheet."
Variation	Before a test or quiz begins, ask students to place the score they are trying for on the upper left-hand corner of their papers. When the graded papers are returned, students will see how their goal and actual score matched. If there is a huge difference, have a conference with the student to see if you can help. Students will begin to realize that goal setting, studying, and paying attention in class will enhance learning.

Worksheet

Math Progress Sheet

Name ______________________________ Date ____________________

First Grading Period Goal ________

Midterm Grade ________

What will I do to accomplish this goal? ________

Weekly Grades

		9/15	9/22	9/29	10/6	10/13	10/20	10/27	11/3	11/10
A										
A-										
B										
B-										
C										
C-										
D										
D-										
F										

Tests or Quizzes

	1	2	3	4	5	6	7	8
A								
A-								
B								
B-								
C								
C-								
D								
D-								
F								

Activity

Problem Problems

Objective	To give students practice in solving problems
Grade Level	Grades 5–6
Time	Variable, depending on number of problems given
Materials	One problem at a time or several (see examples below)
Procedure	Use the problems on the following page or problems from books on resource list to challenge students. Other excellent sources of problems are your text or the math books of other publishers. Check your local university library for these.

1. A bottle and a cork cost one dollar and a dime. The bottle cost one dollar more than the cork. How much did the cork cost? (Answer = .05)

2. Sue bought a turtle for $5. She sold it to Ben for $7. Ben did not want to keep the turtle, so Sue bought the turtle from Ben for $8. By now the turtle was bigger so she sold it to Ann for $9. How much money did Sue make? (Answer = $3)

3. If there are four people in a room and everybody shakes hands once with each of the other people, how many hand shakes will there be? (Answer =6)

4. Ms. McDonald had a farm with ducks and donkeys. There were 24 animals in all. Counting webbed feet and hoofed feet, if these animals had a total of 62 feet, how many ducks and how many donkeys could Ms. McDonald have? (Answer = 17 ducks and 7 donkeys)

5. Susan had 5 cages and 10 guinea pigs. She wanted to put her guinea pigs into the cages so that each cage contained a different number of animals. How could this be done?

   Answer: Cage 1: 0
   Cage 2: 1
   Cage 3: 2
   Cage 4: 3
   Cage 5: 4
   4 + 3 + 2 + 1 + 0 =10

Resources

Barrata-Lorton, M. 1976. *Mathematics their way*. Menlo Park, CA: Addison-Wesley.

Mathematics their way features an activity-centered manipulative math program in which children learn through using all five senses. The curriculum consists of many activities that focus on counting, classifying, graphing, estimating, and measuring. All activities are appropriate for students in grades K–2. The program teaches math concepts so that all children understand them, regardless of their abilities.

Barrata-Lorton, R. 1977. *Mathematics, a way of thinking*. Menlo Park, CA: Addison-Wesley.

This book describes an activity-centered manipulative mathematics program for grades 3–6. The program is similar to the one presented in *Mathematics their way*.

Casserly, P. L. 1983. "Encouraging young women to persist and achieve in mathematics." *Children Today* 12, no. 1: 8–12.

Casserly's article summarizes the factors that enhance or inhibit young females in their study of mathematics. Many strategies for elementary classrooms, counselors, and parents are discussed.

DeRoche, E. F., and Bogenschild, E. G. 1977. *400 group games and activities for teaching math*. West Nyack, NY: Parker.

This book includes 400 classroom-tested math strategies and activities suitable for use in cooperative mathematics learning for elementary and junior high students. The activities are enjoyable and focus on the practical implications of learning math in a cooperative classroom atmosphere.

Fennell, F., and Williams, D. 1986. *Ideas from the* Arithmetic Teacher: *Grades 4–6 intermediate school*. Reston, VA: National Council of Teachers of Mathematics.

This is a collection of classroom-tested activities from the journal *Arithmetic Teacher*. Perforated pages allow easy duplication of activities, which can be used for supplementing, extending, or reinforcing daily mathematics lessons in numeration, whole number computation, rational numbers, geometry, measurement, and problem solving. Objectives, grade levels, directions, and answers are given for each activity.

Holden, L. 1987. "Math: Even middle graders can learn with manipulatives." *Learning 87* 16, no. 3: 52–55.

Learning fractions can be frustrating; this article includes many ways that manipulatives can be used to help upper elementary students understand fractions and learn geometric concepts.

Jensen, R., and Spector, D. 1984. *Teaching mathematics to young children*. Englewood Cliffs, NJ: Prentice-Hall.

This teacher and parent resource suggests many activities that can be used to explore math concepts with young children. The suggested vehicles for math instruction—including manipulative and creative movements, art activities, and games—allow children to tackle new ideas while developing problem-solving skills. Chapters and activities are organized from concrete to abstract, so that young children may master mathematical concepts and gain confidence in learning.

Overholt, J. L. 1978. *Dr. Jim's elementary math prescriptions.* Santa Monica, CA: Goodyear.

Dr. Jim's elementary math prescriptions is a resource for educators in grades K–8 who are searching for effective methods of teaching mathematics. Each mathematical concept is presented with alternative methods to accommodate students with varied learning styles, abilities, and interests. Selected activities provide enjoyable mastery practice, so that students will develop mathematical competence and appreciation.

Stenmark, J. K.; Thompson, V.; and Cossey, R. 1986. *Family math.* Berkeley: University of California, Lawrence Hall of Science.

If mathematics promotion is a goal of your teaching, *Family math* activities will help you introduce parents and children to ideas that improve their math skills and help them gain an appreciation for math. Hands-on mathematical experiences provide families an opportunity to develop problem-solving skills by using the following strategies: looking for patterns, drawing pictures, working backwards, working cooperatively with a partner, and eliminating possibilities. Spatial relationships (geometry), estimation, data interpretation (probability and statistics), and mathematical reasoning are the mathematical concepts learned from *Family math*. Materials suitable for ages 5–18.

Encouraging Independent Thinking, Intellectual Risk Taking, and Creative Problem Solving

Creativity in mathematics has been defined as "the ability to produce original or unusual applicable methods of problem solution; . . . combine ideas, things, techniques and approaches in a new way; [or] . . . analyze a given problem in many ways, observe patterns, see likenesses and differences, and on the basis of what has worked in similar situations, decide on a method of attack in an unfamiliar situation" (Aiken 1973). Creativity sometimes requires that a person take the risk of standing out or of being different from others. Creativity in mathematics requires that students feel independent and confident enough about themselves and their abilities to stand up for their own ideas.

Girls in our culture have traditionally been more dependent than boys; they are reluctant to take intellectual risks, and they are very concerned about "looking stupid" or being embarrassed. Girls are also less likely to ask questions or to experiment with different methods to solve a problem. Since creativity is extremely important in advanced mathematics, it is necessary that we help girls experience their own creativity at an early age.

- Girls are less willing than boys to be wrong and less likely to experiment with different ways to solve a problem. (Kreinberg and Stenmark 1984)

- Independence training facilitates math achievement, and the early socialization of girls typically includes less independence training than that of boys. (Stage et al. 1985)

- Humiliation by a teacher was a primary reason given by a sample of high school girls who decided not to continue in math. (Sherman 1982)

- In the classroom, boys are more often encouraged to be creative and to persevere, whereas girls are rewarded for being docile and conforming. (Harway and Astin 1977)

- Girls' creativity is decreased in competitive situations. (Amabile, cited in Kohn 1986)

- Although teachers' practice of not being too hard on girls in mathematics may be well intentioned, it results in girls not becoming independent problem solvers who do well in high-level cognitive tasks. (Fennema 1983)

- Teachers reported that they rewarded the creative activity of boys three times as often as that of girls. (Torrance, cited in Grayson and Martin 1988)
- In most traditional schools, boys become leaders in problem solving, whereas girls become followers. (Minuchin, cited in Fox et al. 1980)
- Children enter school with girls tending to be more dependent on others and boys tending to be more self-reliant; through classroom practices, schools reinforce and further develop these dependent/ independent behaviors in each sex—particularly in mathematics. (Fennema 1983)
- Several authors have speculated that the greater attention, both positive and negative, that boys receive in the classroom makes them more exploratory, more autonomous, more independent, and more oriented toward achievement in mathematics. (Stockard et al. 1980)

The strategies and activities that follow are designed to help students experience creative problem solving and to help them learn to take risks without worrying about experiencing embarrassment or humiliation.

Strategies

1. To develop creativity in students, a teacher must provide opportunities for personal initiative and responsibility. Although girls seem to be more creative in group situations, they also need to learn to become independent.

2. Structure some activities in your math classes where guessing is encouraged, and there is no penalty for wrong answers. Make it "okay" and never embarrassing for girls to give a wrong answer. Use wrong answers to help the student think through the process and come up with the correct answer, without humiliation. Build a "safe" environment in your class in which everyone can take intellectual risks without fear of embarrassment.

3. Some teachers model making a mistake; they have the class help them think it through, and then find the correct solution to a problem. This can have a positive effect on your female students by letting them know that everyone makes mistakes, and that we can often learn more from our errors than from our successes.

4. Stress alternative approaches to problem solving and understanding mathematical concepts. Researchers have found that girls often use verbal strategies to solve problems, when spatial strategies such as diagramming, organizing the information into charts, or working backwards would be more helpful. Teach different approaches and strategies for problem solving, and encourage girls to use them—especially visual/spatial strategies and manipulatives—when they are unable to solve a problem using traditional methods.

5. Some authors have explained girls' relatively stronger math achievement in the elementary grades and lower achievement in high school by the following: girls are taught and encouraged to obey rather than challenge rules. This may prepare them very well for elementary math, but hinder them tremendously at advanced levels. Be sure you encourage both girls and boys to examine and challenge the "rules" of math; through this process comes understanding rather than dependence on rules.

6. The same types of guessing, checking, and estimating activities that are discussed in the section on building math confidence can also be appropriately used to increase students' intellectual risk-taking behaviors. Many teachers have noted that girls seem afraid to guess, and that they dislike estimating activities. Present these as "fun" activities, and be sure to specifically involve girls in these processes.

7. Some teachers have speculated that because of societal pressures, girls are expected to be well-behaved "perfect ladies," while boys are expected to "have more fun." This pressure can lead to girls' fear of taking risks and making mistakes. Try to ensure that girls enjoy and have fun with math activities.

8. Use "brainstorming" to encourage intellectual risk-taking. Encourage students to develop problems for the class to solve and to present their solutions for the class.

9. Insist that girls become independent, self-reliant problem solvers. Be sure to reward their creative efforts and intellectual risk-taking behaviors.

10. The books *How to encourage girls in math and science* by Skolnick et al., *Math for smarty pants* by Burns, *Solving problems kids care about* by Souviney, *Math for girls and other problem solvers* by Downie et al., *Mastermind* by Clements and Hawkes, and *Use EQUALS to promote the participation of women in mathematics* by Kaseberg et al. contain excellent examples of problems you can use to supplement texts. Additional information on these books can be found in the resource list following this subsection.

11. The ability to "break set," or see beyond the expected, is one element of independent thinking and creativity in mathematics. The book *Math for girls and other problem solvers* by Downie et al. contains a number of activities that help children learn to break set. These include a series of "mystery stories" in which students have to look beyond the obvious to solve a problem and toothpick puzzles, which involve breaking visual set to find new patterns.

12. Many of the books mentioned above also contain good examples of logic problems. These give students practice using deductive reasoning to solve problems. *Family math* by Stenmark et al. (see resource list) contains an excellent game called Rainbow Logic, which also teaches reasoning in a very interesting way.

13. Look at the "Mindwinders" columns in *Instructor* magazine for interesting logic problems for your students.

Activity

Strategy Games—Card Tricks and Mind Reader

Objectives To allow students to discover and practice problem-solving strategies

Grade Level Grades 1–6, depending on problem complexity

Time 10–20 minutes

Materials A deck of playing cards with the jokers removed, scratch paper, and pencils

Procedure *Card Tricks.* Demonstrate this trick first. Then play the game over, and let students guess the card. To play the game, you leave the room, and a student selects a card from the deck and places it face down on her or his desk. For grades 1–3, use only one suit with numbered cards 2–10; for grades 4–6 use the entire deck. Explain to the older group that the Ace is the lowest card and that the order of the cards above the 10 is Jack, Queen, King. Also define the suits. The object of the game is for the person doing the "card trick" to guess the turned down card in as few guesses as possible. For the younger group using only one suit with cards 2–10, the person doing the "trick" can ask the following types of questions: "Is it higher than 5?", "Is it lower than 3?", "Is it the 10?", and so forth. (Note that if the card was the 5 and the question was "Is it higher than 5," the answer would be "no." If the card in question was the 3 and the question was "Is it lower than 3," the answer would be "no." For the advanced trick with the entire deck of 52 cards, questions can *also* include the color and suit; i.e., "Is it a red card?" and "Is it a spade?" The answers can only be "yes" or "no."

Allow students to use paper and pencils to keep track of their guesses. For each game, designate one student as monitor, and let that student count and write the guesses on the board. Seeing how questioning has progressed should help students develop successful strategies. This game also teaches the value of wrong guesses, for example, when students ask, "Is it a red card?", and the answer is "no," they have now narrowed it down to a black card. In this game a "no" answer can sometimes be more valuable than a "yes."

After you have demonstrated the trick, select a card, place it face down, and let the class guess it. Help students focus on developing a strategy to narrow down their choices and rule out incorrect answers.

Mind Reader. This game is similar to Card Tricks. One person thinks of a number and writes it down. For grades 1–3, use single-digit or possibly two-digit numbers. For higher grade level students use 2–4 digit numbers. The person thinking of the number tells the group (the "mind readers") the number of digits. Students may ask questions similar to those in Card Tricks; i.e., "Is it higher than 5?", "Is it lower than 300?" Again, the object is to "read the person's mind" and guess the number in as few tries as possible.

Variation

The book *Use EQUALS to promote the participation of women in mathematics* by Kaseberg et al. (see resource list following this section) contains several strategy games, including Bagels, another interesting guessing game that involves strategy development and may be played on several levels of complexity.

Activity

Find the Missing Numbers

Objective To allow students to practice adding and multiplying in a problem-solving format

Grade Level Grades 2–3 (worksheet A), 4–6 (worksheets B and C)

Time 10–30 minutes

Materials Worksheets A, B, and C on the following pages

Procedure Duplicate one work sheet for each student. Ask students to complete the sheets using the hints provided on them. One set of answers is shown on the following page. Alternative solutions are possible for several of the squares. Suggest a trial-and-error approach to finding a set of missing numbers. To help students get started, you might supply one or more numbers for each square.

Answers to problems on worksheet A:

Row 1	2	4	2	3	5	4	2	5
	3	5	5	4	3	2	4	3
Row 2	1	5	3	7	5	1	7	9
	3	7	5	9	9	3	1	5
Row 3	1	2	5	5	4	1	4	6
	3	1	4	2	3	4	6	3
Row 4	1	4	4	5	7	2	9	2
	2	9	3	6	4	3	4	3

Answers to problems on worksheet B:

Row 1	1	3	6	3	1	2	5	1	5
	4	2	7	4	3	5	2	6	3
	2	5	2	7	6	3	5	4	7
Row 2	1	6	7	2	1	9	1	7	2
	5	3	4	4	5	7	4	5	3
	9	2	5	3	5	6	5	3	8

Answers to problems on worksheet C:

Row 1	2	4	3	5	3	2	3	5	2
	3	4	1	2	5	5	4	6	1
	5	5	2	6	3	1	2	3	4
Row 2	1	2	15	3	1	20	30	4	1
	10	1	3	25	2	1	1	40	3
	4	5	1	1	5	4	2	1	35

Variation

Encourage students to construct similar problems with or without hints for others to solve.

Worksheet

Find the Missing Numbers (A)

Directions: Fill in the squares so that the sum of each row and column of numbers is equal to the outside numbers. Hints about the missing numbers are given for each row.

Hint: The missing numbers for these squares can only be 2s, 3s, 4s, or 5s.

ROW 1

		6
		8
5	9	

		5
		9
7	7	

		9
		5
8	6	

		7
		7
6	8	

Hint: The missing numbers in these squares are odd numbers. Use numbers 1–9.

ROW 2

		6
		10
4	12	

		10
		14
8	16	

		6
		12
14	4	

		16
		6
8	14	

Hint: In each of these squares, two missing numbers are the same. Use numbers 1–9.

ROW 3

		3
		4
4	3	

		10
		6
9	7	

		5
		7
7	5	

		10
		9
10	9	

Hint: Half of the missing numbers below are odd, but you never add two odd numbers together. Use numbers 1–9.

ROW 4

		5
		11
3	13	

		9
		9
7	11	

		9
		7
11	5	

		11
		7
13	5	

Worksheet

Find the Missing Numbers—Adding (B)

Directions: Fill in the squares so that the sum of each row and column of numbers is equal to the outside numbers. Hints about the missing numbers are given for each row.

Hint: In each square, one of the missing numbers is used twice; all answers use numbers 1–7.

ROW 1

1			10
		7	13
2			9
7	10	15	

	1		6
4			12
		3	16
14	10	10	

		5	11
2			11
	4		16
12	11	15	

Hint: When you complete these squares, each row will contain two odd numbers; select from numbers 1–9.

ROW 2

1			14
	3		12
		5	16
15	11	16	

		9	12
	5		16
3			14
9	11	22	

	7		10
	5		12
	3		16
10	15	13	

Worksheet

Find the Missing Numbers—Multiplying (C)

Directions: Fill in the squares so that the outside numbers are the *product* of all the numbers in the row or column inside the grid.

Hint: In all three of these squares, two of the missing numbers are 2s. The other four numbers can be selected from numbers 1, 3, 4, 5, and 6. When it's finished, every square will contain two 3s.

ROW 1

		3	24
	4		12
5			50
30	80	6	

5			30
	5		50
6			18
60	45	10	

	5		30
4			24
		4	24
24	90	8	

Hint: Each row in each square contains a 1. The other three numbers are 5s or multiples or 5, and they can go as high as 40.

ROW 2

	2		30
		3	30
4			20
40	10	45	

3			60
	2		50
		4	20
75	10	80	

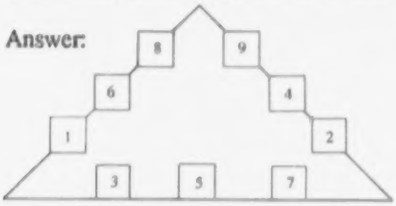
	4		120
		3	120
2			70
60	160	105	

Activity

Parts Add Up

Objective	To allow students to experiment with mathematical strategies to discover how the numbers 1–9 can be arranged in groups of three to add up to the same total
Grade Level	Grades 3–6
Time	20 minutes
Materials	One copy of the triangle with "square" sides (see following page) for each student
Procedure	Hand out triangle with squares. Instruct students to arrange the numbers 1–9 in the squares so that each side has the same total. Each number can only be used once. Students can work individually or in groups. Encourage students to share the process they used to figure their answers.

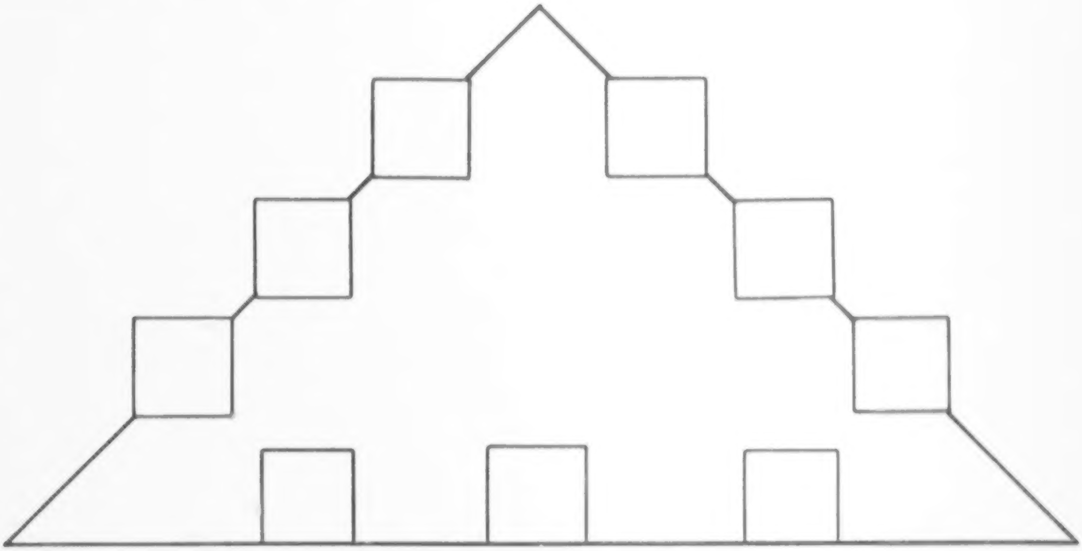
Answer:



Possible strategies: Trial and error with the nine numbers. Add the numbers and divide by 3; that tells us that each side must equal 15. Now use trial and error to find sets of numbers that will add to 15.

Handout

Parts Add Up Triangle



Activity

Creative Numbers

Objective To help students become aware of the many ways numbers are used in everyday life

Grade Level Grades 3–6

Time 20–30 minutes

Materials One copy of "Creative Numbers" worksheet on the following page for each student (To use as an activity for the entire class, put on the board or use with an overhead projector.)

Procedure Ask students to use their imaginations to determine what the letters stand for on the worksheet. Let the entire class brainstorm together or divide the class into small groups. Students can also be asked to make their own creative number statements or to take a copy of the sheet home and ask their parents for help. Note that students might come up with some answers that are different from the ones we show below. If the answer fits, it's correct!

Answers:

1. days of the week
2. months of the year
3. legs on a centipede
4. quarters in a dollar
5. cents in a dime
6. legs on a millipede
7. legs on a spider
8. things in a dozen
9. states in America
10. sides on a triangle
11. letters in the alphabet
12. planets in the solar system
13. stripes on the American flag
14. hours in a day
15. eyes on a face
16. legs on a human being
17. pins on a bowling lane
18. blind mice

Worksheet

Creative Numbers

Directions: We use numbers in many ways. Each statement below contains numbers and the initials of words that will make it correct. Fill in the correct words.

Example: 2 A on a B Answer: 2 arms on a body

1. 7 D of the W ____________________
2. 12 M of the Y ____________________
3. 100 L on a C ____________________
4. 4 Q in a D ____________________
5. 10 C in a D ____________________
6. 1000 L on a M ____________________
7. 8 L on a S ____________________
8. 12 T in a D ____________________
9. 50 S in A ____________________
10. 3 S on a T ____________________
11. 26 L in the A ____________________
12. 9 P in the S S ____________________
13. 13 S on the A F ____________________
14. 24 H in a D ____________________
15. 2 E on a F ____________________
16. 2 L on a H B ____________________
17. 10 P on a B L ____________________
18. 3 B M ____________________

Activity

The Pizza Store

Objective	To allow students to discover the rules for determining combinations
Grade Level	Grades 4–6
Time	10 minutes per problem
Materials	"The Pizza Store" handout on the following page
Procedure	Divide students into small groups. Give each group a copy of the handout. Define "combinations," and then let students, working in groups, build their own pizzas using the problems outlined on the following page.

Answers:

a. 8 different pizzas

b. 4

c. 24

d. 48

e. The rule is to multiply the number of choices in each category together, i.e., A = 2 x 2 x 2 = 8, B = 1 x 2 x 2 = 4, C = 2 x 2 x 2 x 3 = 24, D = 2 x 2 x 2 x 2 x 3 = 48.

Handout

The Pizza Store

The pizza store started out with the following menu:

Crusts	*Cheeses*	*Meats*
Thick	Mozzarella	Sausage
Thin	Provolone	Pepperoni

a. If customers choose one kind of crust, one kind of cheese, and one kind of meat on every pizza, how many different kinds of pizza (or combinations) could the pizza store make? *Note:* cheese has to be in the middle with meat on top.

b. The pizza store owner decided that it was too much trouble to make two crusts, so she would make only thin crust. How many combinations could the store make if customers still choose only one kind of cheese in the middle and one kind of meat on top?

c. After a while, the pizza store owner decided that she would go back to making two kinds of crust, and she would also add three kinds of vegetables—onions, green peppers, and mushrooms. Now, if customers could choose one kind of crust, one kind of cheese, one kind of meat, and one kind of vegetable on each pizza, how many different kinds of pizza could she make?

d. What if the owner decided to have 2 sizes of pizza—small and large? Now how many different combinations would be possible?

e. Can you figure out a rule for solving these problems?

Activity

A Penny for Wages

Objective

To practice problem solving, learn the "time" value of money (Problem A), and practice finding different solutions (Problem B)

Grade Level

Grades 5–6

Time

10–15 minutes per problem (These could serve as problems of the day.)

Materials

"A Penny for Wages" handout on following page and calculators (if available) (For additional problems, use books from the resource list or math texts.)

Procedure

Problem A: Let students read the problems on the following page. Before they attempt a solution, let students estimate and vote on their answers. Then allow about 10–15 minutes for solution with calculators.

Problem B: Working in pairs, have students read the word problem and find two different methods to solve it.

Answers:

Problem A: At one cent doubling every hour, Susan would earn $328 in two days.

Problem B: Solution (l) Fill the 5-quart can. Then pour from it to fill the 3-quart can; you will have two quarts left in the 5-quart can. Pour the remaining 2-quarts into the mower. Repeat the process, filling the 5-quart, transferring to the 3-quart, and putting the remaining two quarts in the mower. Two quarts plus two quarts equals one gallon. Solution (2) Fill the 3-quart can; pour it into the 5-quart can. Fill the 3-quart can again, and use that gasoline to fill the 5-quart can. The 5-quart can will take two more quarts with one left over. Pour the remaining quart into the mower. Then transfer the gas from the 5-quart can back to the 3-quart can. Pour the full 3-quart can into the mower. One quart plus three quarts equals one gallon.

Variation

Using their calculators, students can develop and find solutions for many problems about savings and interest that involve compounding. For example, if you put $10,000 in a savings account that earns 8% interest per year, and you left all the money in the account, how long would it take before your money had doubled (to $20,000)?

Handout

A Penny for Wages

Problem A

Susan was offered a job that would last only two days. Her boss said she could choose either to earn $100 a day or to start at one penny per hour and then her salary would double every hour. If Susan were going to work two days for eight hours per day, which would be the best deal—$100 per day or starting at one cent per hour with her wage doubling every hour? Which would you choose?

Problem B

Monica and Pat were making money by mowing lawns during the summer. The mower used a mixture of gasoline and oil. They had two gas cans—one held three quarts and the other held five quarts. The cans were not marked in any way. The lawn mower required exactly one gallon of gasoline to be mixed with one quart of oil. Using the 3-quart and 5-quart containers, how did the girls measure exactly one gallon of gasoline? Write two different solutions.

Resources

Burns, M. 1982. *Math for smarty pants.* Boston: Little, Brown.

This book contains a wide range of accessible activities presented in an entertaining format. It would be particularly useful for expanding upper elementary students' perceptions of mathematics.

Burns, M. 1975. *The I hate mathematics book.* Boston: Little, Brown.

For those students who "seemingly" hate mathematics, this book provides many relevant activities to boost confidence and aspirations. Positive attitudes toward mathematics develop as students experiment with and investigate the uses of mathematics in solving everyday problems. Suitable only for upper elementary students.

Clements, Z. J., and Hawkes, R. R. 1985. *Mastermind: Exercises in critical thinking, grades 4–6.* Palo Alto, CA: Scott, Foresman.

Mastermind activities are designed to foster the mathematical learning strategies of talented and gifted students in elementary school. The activities have been grouped according to Bloom's Taxonomy of Educational Objectives. The hierarchical organization of the book's contents enables educators to use the activities as supplemental material to develop new critical thinking skills and to reinforce previously learned mathematical skills.

Cook, M. *Math materials.* Catalog. Balboa Island, California.

These materials include tiling sets, task cards, and books designed to add variety to math. The materials emphasize problem solving and focus on active student involvement. Also included are several books on cooperative learning. A catalog is available from Marcy Cook, P.O. Box 5840, Balboa Island, CA 92662.

Coombs, B.; Harcort, L.; Travis, J.; and Wannamaker, N. 1987. *Explorations.* Menlo Park, CA: Addison-Wesley.

A mathematics program based on learning through the use of manipulatives and interacting with the environment. Programs for K–2 and 3–6 integrate math and language arts.

Downie, D.; Slesnick, T.; and Stenmark, J. K. 1981. *Math for girls and other problem solvers.* Berkeley: University of California, Math/Science Network.

The activities in this book encourage independent thinking and creativity in mathematics. Students and teachers are encouraged to think about problem solving in versatile ways and forms. Although this book was originally designed for females, the activities are appropriate and interesting to both boys and girls, ages 7–14.

Fennell, F., and Williams, D. 1986. *Ideas from the arithmetic teacher: Grades 4–6 intermediate school.* Reston, VA: National Council of Teachers of Mathematics.

This is a collection of classroom-tested activities from the journal *Arithmetic Teacher.* Perforated pages allow easy duplication of activities, which can be used for supplementing, extending, or reinforcing daily mathematics lessons in numeration, whole number computation, rational numbers, geometry, measurement, and problem solving. Objectives, grade levels, directions, and answers are given for each activity.

Fraser, S., ed. 1982. *SPACES: Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are designed for students in grades 4–10.

Holden, L. 1987. "Math: Even middle graders can learn with manipulatives." *Learning 87* 16, no. 3: 52–55.

Learning fractions can be frustrating; this article includes many ways that manipulatives can be used to help upper elementary students understand fractions and learn geometric concepts.

Jensen, R., and Spector, D. 1984. *Teaching mathematics to young children.* Englewood Cliffs, NJ: Prentice-Hall.

This teacher and parent resource suggests many activities that can be used to explore math concepts with young children. The suggested vehicles for math instruction—including manipulative and creative movements, art activities, and games—allow children to tackle new ideas while developing problem-solving skills. Chapters and activities are organized from concrete to abstract, so that young children may master mathematical concepts and gain confidence in learning.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. Ultimately, the purpose of the program is to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction. Materials are suitable for grades 4–12.

Overholt, J. L. 1978. *Dr. Jim's elementary math prescriptions.* Santa Monica, CA: Goodyear.

Dr. Jim's elementary math prescriptions is a resource for educators in grades K–8 who are searching for effective methods of teaching mathematics. Each mathematical concept is presented with alternative methods to accommodate students with varied learning styles, abilities, and interests. Selected activities provide enjoyable mastery practice, so that students will develop mathematical competence and appreciation.

Silvey, L., and Smart, J. R., eds. 1982. *Mathematics for the middle grades (5–9).* Reston, VA: National Council of Teachers of Mathematics.

This book was developed to aid teachers in promoting the mathematical development of students in grades 5–9. The three sections of the book cover critical issues in mathematics education, unique learning activities, and strategies for teaching problem solving.

Skolnick, J.; Langbort, C.; and Day, L. 1982. *How to encourage girls in math and science: Strategies for parents and educators.* Palo Alto, CA: Dale Seymour Publications.

This excellent resource examines the effect of sex-role socialization on girls' math/science skills and confidence. It explains how attitudes, parenting and teaching practices, stereotypical play activities and books, peer pressure, and career and family expectations cause girls to question their abilities in math and science, and thus hinder their development in these areas.

In addition to the summary of the socialization process, the book contains a variety of compensatory educational strategies and activities that may be used to encourage females in mathematics. These particularly focus on increasing math confidence, spatial visualization skills, and problem solving. Both parents and educators can benefit from this book.

Souviney, R. J. 1981. *Solving problems kids care about.* Palo Alto, CA: Scott, Foresman.

Solving problems kids care about is divided into two parts. The first section includes notes and strategies for teaching mathematical problem solving. The second section contains thirty real-world problems that encourage divergent and logical thinking. Many of the problems have a range of acceptable solutions and multiple solution strategies, so students have the opportunity to be creative and independent thinkers. Activities are designed for elementary through junior high school students; teachers will enjoy them also.

Stenmark, J. K.; Thompson, V.; and Cossey, R. 1986. *Family math.* Berkeley: University of California, Lawrence Hall of Science.

If mathematics promotion is a goal of your teaching, *Family math* activities will help you introduce parents and children to ideas that improve their skills and help them gain an appreciation for math. Hands-on mathematical experiences provide families an opportunity to develop problem-solving skills by using the following strategies: looking for patterns, drawing pictures, working backwards, working cooperatively with a partner, and eliminating possibilities. Spatial relationships (geometry), estimation, data interpretation (probability and statistics), and mathematical reasoning are the mathematical concepts learned from *Family math.* Materials suitable for ages 5–18.

Wiebe, A., and Hillen, J., eds. 1986. *AIMS Newsletter.* Fresno, CA: AIMS Education Foundation.

This newsletter describes the AIMS (Activities that Integrate Math and Science) program. The program includes a wide range of science and math activities and focuses on the integration of learning experiences, problem-solving activities, and cooperative learning.

Part 4

Other Issues

This section of the guide contains activities, strategies, and resources to assist you with several areas in which girls often need special help and/or encouragement. These areas are

1. computer access
2. spatial visualization skills
3. test-taking skills

Increasing Computer Access for Girls

We are now witnessing the incorporation of the computer into all aspects of our lives. There are indications that both at school and at home, girls have less access to computers than boys. When they do have access, girls are being channeled into lower-level computer activities.

- Girls express less interest than boys in learning about or using computers; they use computers outside of class less than do boys. (Miura 1987)
- Girls have been found to be more reluctant than boys to assume computer leadership roles, such as class assistant, tutor, etc. (Bakke et al. 1985)
- When both boys and girls are sharing computers, boys often monopolize the computer, refusing to take turns; girls then become passive rather than active participants. (Schubert 1986)
- Much leisure activity software incorporates violent and competitive war-like games which appeal more to boys than to girls. (Kreinberg et al. 1985)
- Left to their own inclinations, fewer girls will become involved with microcomputers available at school; junior high age girls are often reluctant to compete with boys for computer time. (Boss, cited in Grayson and Martin 1988)
- In California only 37 percent of students enrolled in high school computer programming classes were females; at one university campus, only 27 percent of students who enrolled in computer classes were female. (Linn and Fischer, cited in Grayson and Martin 1988)
- Female enrollment in computer summer camps was only 24 percent in 1982 (Kreinberg et al. 1985). The disparity in male/female computer camp enrollment increases with age and cost. (Hess and Miura, cited in Grayson and Martin 1988)
- There are twice as many boys as girls enrolled in high school computer science courses which teach programming and which lead to careers in computer science and systems analysis; however, in business education courses that offer computer training in word processing and lead to clerical occupations, there are twice as many girls. (Sadker and Sadker 1985)

Because computers are expected to take an increasing role in modern society, it is vitally important that we ensure that girls are being given opportunities to learn and enjoy computer programming. The strategies and activities on the following pages assume that you have computers available for students in your school.

Before looking through the strategies and activities in this section, you might want to assess the computer learning climate for girls at your school.

Answer the following questions:

1. Is there a lack of encouragement for girls to use computers?
2. Is the potential value of computer learning more apparent to boys than to girls?
3. Is there a bias against girls in software and advertising?
4. Does your school have prerequisites that are irrelevant for computer access and instruction (such as math)?
5. Is there limited computer access for girls during free time?
6. Is there underrepresentation of girls in computer leadership roles?
7. Is there dominance by one student over another during computer time? Are the dominant students typically boys?
8. Do you see pressure from girls' peers not to participate in computer activities?
9. Is there underrepresentation of girls in computer clubs?
10. Is there inappropriate location of computers in your school?
11. Is there an inability of teachers and students to recognize and deal with problems in computer learning?
12. Is there a shortage of qualified personnel for computer learning?
13. Is there a shortage of computer time?
14. Is there a shortage of software that is interesting to girls?

The strategies and activities on the following pages include suggestions for dealing with these problems.

Questions 1–12 were reprinted, by permission, from "Educator's self-assessment for equitable computer learning" in *Ideas for equitable computer learning* by Thomas Bakke et al. Copyright 1985 by American Institutes for Research, Palo Alto, California.

Strategies

1. Find out more about the computer gender gap, and be aware of the career implications of computer illiteracy for girls. The resource list at the end of this section contains several informative articles.

2. If your computer center is thought of as primarily a male game-playing area, change that image to one of a learning center for all students.

3. Make sure that you use software that teaches students to become problem solvers and is interesting for girls as well as boys. Eliminate materials that are primarily oriented toward one sex, such as aggressive games. Use programs that are open-ended and exploratory.

4. Make special efforts to provide access to computers for students who do not have home computers; demonstrate the value of computers by encouraging their use for extracurricular activities.

5. Stress application programs and problem solving activities rather than pure programming in introductory computer courses. If students see the usefulness of computers first, they will become more interested in learning the mechanics of programming later. Provide a wide range of computer experiences for students. Investigate problem-solving software such as "Safari Search" or "Teasers by Tobbs" available from Sunburst Communications; spreadsheet software such as Appleworks; and geometry-related software such as the series of "Geometric Supposer" programs from Sunburst.*

6. Encourage parents to support both boys' and girls' involvement in computer learning. Parents and teachers can form a parent-teacher computer use group to share information; they might also raise funds to purchase computers for schools or to provide further computer education for teachers.

7. Role models are very important. Girls become more interested in computers when they see their mothers using them. Parents might initiate a mother-daughter computer club or investigate a mother-daughter computer class. Also, it is worth noting that every woman profiled in the stories in the role model section of this guide uses computers in her work.

8. Make other special efforts to involve girls in computer learning by developing a computer club for girls and encouraging girls to find friends with whom they can share computer experiences at school or at home.

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* Portions of Strategies 2–5 were suggested in "Sex equity: Increasing girls' use of computers" by Lockheed and Frankt, in *Computing Teacher* 11, no. 7: 16–18.

9. Plan for equal access and use of computers by boys and girls. In the beginning, this may require you to set aside certain times for "girls only" or to develop other procedures that ensure equal time for both sexes. Use a log-on sheet like the one following this list of strategies.

10. Other strategies for equal access include:

    a. Distribute "tickets" of different colors to all students who want to use your computer lab (or who are enrolled in computer classes). Use the ticket colors to regulate access to the lab. For example, students with yellow tickets could be admitted first on Mondays, and students with tickets of other colors could fill any leftover spaces. Students with blue tickets could be admitted first on Tuesdays, etc. You could issue only two colors of tickets and use them on alternate days, before and after school, or for the first and second half of the lunch period. Change the pattern often to give everyone a chance.

    b. Reserve some computers for girls and some for boys. You can use this technique on a first-come, first-served basis during free periods, or you can have students sign up ahead of time.

    c. Set aside one day of the week for boys to use the lab exclusively and another day for girls. It may take some time for students to take advantage of this policy, so give it a trial period of six weeks or more before you decide to alter it. Publicize the policy and place a poster in the lab to remind students of "Boys Only" and "Girls Only" days.

    d. Alter the environment in the computer lab so that it appeals to all students. If the focus is mainly on males (violent games, male-dominated graphics or art), try to include software activities and bulletin board materials that interest girls as well. Ask the girls to suggest ideas for creating a comfortable environment.

11. To motivate all students to become involved in computer learning, show them how computers are used in the real world. Some strategies include:

    a. Plan field trips to local businesses that use computer technology so that your students can see what people do with computers, what training and education the employees need, what the job environment is, and what the job satisfaction is. Try to locate nontraditional role models.

    b. Incorporate computer use into other classroom activities such as the school newspaper, recording students' achievements in school sports, keeping track of individual sales for fund-raising activities, and preparing documents for field trips (parent permission slips, instructions to students, guides of "what to look for," etc.).

Strategies 10 and 11 were reprinted, by permission, from *Ideas for equitable computer learning* by Thomas Bakke et al. Copyright 1985 by American Institutes for Research, Palo Alto, California.

  c. Work with other teachers and volunteers to design computer activities that demonstrate immediate and long-term relevance. Have each person critique another's ideas. Use these activities to build up the computer center as a school resource for other teachers. Show them what support a computer can be in easing their workload and in providing ways for students to apply their computer skills.

  d. Try linking computers to careers so that students must think ahead and analyze how they might use their computer skills in the future. Ask students to write a three-part essay or give a talk dealing with these ideas: (a) What I Plan to Do in the Future, (b) What Role Will a Computer Probably Play in This Plan, and (c) How I Can Prepare for That Career. If there are students who do not believe that the computer will affect their careers, use those careers as the basis for a discussion, and have the class talk about possible uses.

  e. As part of an assignment, have advanced students suggest class activities that require the practical application of computer technology. Have students share the better ideas with the rest of the class. Try out and refine these ideas for use with future classes.

12. Obtain a copy of *Ideas for equitable computer learning* by Bakke et al. (see the resource list at the end of this section) for a number of excellent strategies to overcome dominance by one student over another during computer time, lack of encouragement for female and minority students to use computers, underrepresentation of females in computer leadership roles, and inability of teachers and students to recognize and deal with problems in computer learning.

13. Use a variety of grouping techniques and types of programs when working with students and computers. For example:

  a. If students are working *individually*, use *drill and practice*, *tutorial*, or *problem-solving* programs. The advantage of individual grouping is that each student controls the content and pace of learning.

  b. If students are working in *small groups*, use *simulations*, *educational games*, and *problem-solving* programs. One of the advantages is that students learn cooperative skills.

  c. If students are working in a *large group*, use *demonstrations of problem solving* with a monitor and a TV screen. With this method all students can receive and view the explanation at one time.

Handout

Computer Log-On

Sign-up sheet for the week of ______________________________

Time	Monday	Tuesday	Wednesday	Thursday	Friday
7:40-8:00					
8:00-8:20					
8:20-8:40					
8:40-9:00					
9:00-9:20					
9:20-9:40					
9:40-10:00					
10:00-10:20					
10:20-10:40					
10:40-11:00					
11:00-11:20					
11:20-11:40					
11:40-12:00					
12:00-12:20					
12:20-12:40					
12:40-1:00					
1:00-1:20					
1:20-1:40					
1:40-2:00					
2:00-2:20					
2:20-2:40					
2:40-3:00					
3:00-3:20					
3:20-3:40					
3:40-4:00					

Directions: Every week post a copy of this sheet in your computer area. The sheet can be used to sign up whole classes or individual students for computer time. Put an X through inconvenient time slots. Make sure everyone has fair access to the computers each week.

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General Computer Information

Types of Software Programs

1. Drill and Practice
   a. tailor instructions to individual students
   b. provide for random selection
   c. give immediate reinforcement

2. Tutorial
   a. tailor instructions to individual students
   b. introduce new concepts
   c. give immediate reinforcement

3. Simulations
   a. approximate real events
   b. compress years into minutes
   c. test hypotheses

4. Problem Solving
   a. work with data
   b. perform rapid calculations
   c. systematize information

5. Educational Games
   a. motivate
   b. present basic facts in new ways
   c. develop logical guessing

Tips on Selecting Software*

Answer the following questions:

1. Will it run on our computers?
2. Is it the content appropriate?
3. Is it right for this grade level?
4. Is it the correct type of program?
5. Does it match the lesson objectives?
6. Will it work in this classroom situation?
7. What does it cost?
8. Does the company provide one free back-up copy?
9. Is there on-site preview of software available?
10. Does the company's copyright provide for multiple copies?

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* Tips collected by Christine Huss, Nevada Department of Education, Carson City, Nevada. Used by permission.

Examples of Highly Rated Software

Building Perspective. (Grades 4–12). Sunburst Communications, 1986. Assists students in thinking spatially and fosters cooperative learning and teamwork.

Function Machine: Level 1. (Grades 4–6). D.C. Heath/Collamore, 1986. Helps students understand numeric relationships.

Math Rabbit. (Grades K–2). The Learning Company, 1986. An educational game with drill and practice. Students receive practice with counting, addition, and subtraction of whole numbers.

Mathematics Activities Courseware (Levels 1 and 2). (Grades 1–2). Houghton Mifflin, 1984. Strengthens basic mathematics and problem-solving skills through the use of games and other activities. Software is correlated with Houghton Mifflin mathematics texts.

Algernon: An Introduction to Programming Logic. (Grades 3+). Sunburst Communications, 1987. Excellent pre-Logo activity; helps develop skills in spatial recognition, estimating, and sequencing, as well as a logical approach to problem solving.

Ant Farm. (Grades 3+). Sunburst Communication, 1987. Helps students develop the problem-solving skills of discerning patterns and making projections.

Discrimination, Attributes, and Rules: The Second Step in Problem Solving. (Grades K–6). Sunburst Communication, 1984–86. Seven programs to build problem-solving skills, includes Teddy's Playground (working with attributes), Iggy's Gnees (discovering secret rules), Odd One Out (classification), Gnee or Not Gnee (guessing rules from examples), Tip 'N Flip (visual discrimination, mental transposition), High Wire Logic (logic and attributes), and Ten Clues (using attributes as clues).

Sources of Courseware Information

Educational Computing Magazines

Electronic Learning
Teaching and Computing
The Computing Teacher
Classroom Computer Learning
Educational Technology
The Mathematics Teacher
The Arithmetic Teacher

Software/Courseware Reviews

TESS: The Educational Software Selector. Educational Products Information Exchange (EPIE) Institute. Teachers College Press, New York, NY 10016 (annual publication)

EPIE Micro-Courseware PRO/FILES. Educational Products Information Exchange (EPIE) Institute, P.O. Box 839, Water Mill, NY 11976

Microgram: The Educational Software Newsletter of the EPIE Institute. Educational Products Information Exchange (EPIE) Institute, P.O. Box 839, Water Mill, NY 11976 (published monthly, with nine issues per year)

Only the Best: The Discriminating Software Guide for Preschool-Grade 12. Linda Mattas, Editor, Educational News Service, P.O. Box 1789, Carmichael, CA 95609 (annual publication)

Digest of Software Reviews: Education. Ann Lathrop, Editor, 1341 Bulldog Lane, Suite C, Fresno, CA 93710

Software Reports: Guide to Evaluated Educational Software. Trade Service Publications, Inc., 10996 Torreyana Road, San Diego, CA 92121 (serial)

Software Reviews on File: Education. James Johnson, Editor, Facts on File, 460 Park Avenue South, New York, NY 10016 (serial)

Good Sources of Software/Courseware

Minnesota Educational Computing Consortium (MECC), 3490 Lexington Avenue, N, St. Paul, MN 55126

Sunburst Communications, 39 Washington Avenue, Pleasantville, NY 10570–9971

The Learning Company, 6493 Kaiser Drive, Fremont, CA 94555

Activity

Meet the Logo Turtle—Building Logo Turtle Turners

Objective

To teach students the skills of moving forward and backward, telling right from left, following directions, estimating distance, using degrees, and plotting points on a grid by introducing students to Logo programming (These Logo activities also help students learn spatial orientation and can be used with a variety of hardware and Logo software.)

Grade Level

Grades 1–3 (No previous knowledge of Logo is required.)

Time

Variable—several 20-minute segments

Materials

Scissors; paste; a brass fastener; crayons or markers; a piece of lightweight cardboard; "Turtle Turners" patterns (see following pages); any version of Logo software, including instant Logo for nonreaders

Procedure

Logo is a programming language created by Seymour Papert and a group of scientists from the Massachusetts Institute of Technology (M.I.T). Students use skills such as moving backward and forward, telling right from left, following directions, estimating distances, and angle measurements to program a cursor-like symbol called the Logo Turtle to move around the computer screen. Logo provides an activity-based setting for developing important problem-solving strategies and thinking skills. The "Turtle Turners" help students position and move the Logo turtle on the screen.

Turtle Turner 1 (for beginners) is helpful in demonstrating the turtle's right and left on a vertical plane. Sometimes this can be a confusing concept for children. For example, a turtle facing down turns to the turtle's right, but to the user's left.

Turtle Turner 2 (for more advanced Logo users) can help students estimate how many degrees right or left to turn the screen turtle so that is pointing toward a specific location.

Make one copy per student of the Turtle Turner patterns that follow these directions. Give each student a pair of scissors, paste, a brass fastener, crayons or markers, a piece of lightweight cardboard, and one Turtle Turner pattern. Tell students to color their Turtle Turners and write their names in the blank provided on the triangle. Instruct them to paste the turtle onto their cardboard. Then have students cut out the triangle and circle shapes. (You may want to laminate the circle and triangle parts at this point.) Help students join the circle and triangle with a brass fastener.

This activity was drawn from "Meet the logo turtle" by E. Dale and L. Hopping, in *Teaching and Computers*, September 1985. Copyright 1985 by Scholastic, Inc. Used by permission.

Using the Turners: To show students how to tell the turtle's right from its left, instruct them to hold Turtle Turner 1 next to the screen (top side up) and point the triangle in the same direction as the screen turtle is pointed. Kids should then slowly turn the triangle in the direction they want the screen turtle to go. The arrows on the triangle tell the students whether to enter a left or a right command in order to point the screen turtle in the same direction as the Turtle Turner. For example, if the triangle is turning in the same direction as its right arrow, students know they must enter a RIGHT turn command to point the screen turtle in the proper direction. Instant Logo users would then press the "R" key. Standard Logo users would enter RIGHT or RT followed by the number of degrees to turn.

Variations

1. Turtle Turner 2 helps students using standard Logo to estimate degree increments. Tell students to hold the Turtle Turner next to the screen so that zero degrees is pointing straight up and the triangle is pointing in the same direction as the screen turtle.

   Students should then slowly turn the triangle either right or left so that it points to a spot where they want the screen turtle to go. Have them record two degree markers: the degrees at which the screen turtle is still pointing and the degrees to which they moved the triangle. To calculate how many degrees they have turned the triangle, tell students to subtract the smaller degree marker from the larger one. For example, if the triangle is pointing at 90 degrees and the screen turtle is pointing at 0 degrees, the triangle has traveled 90 degrees (90 – 0 = 90).

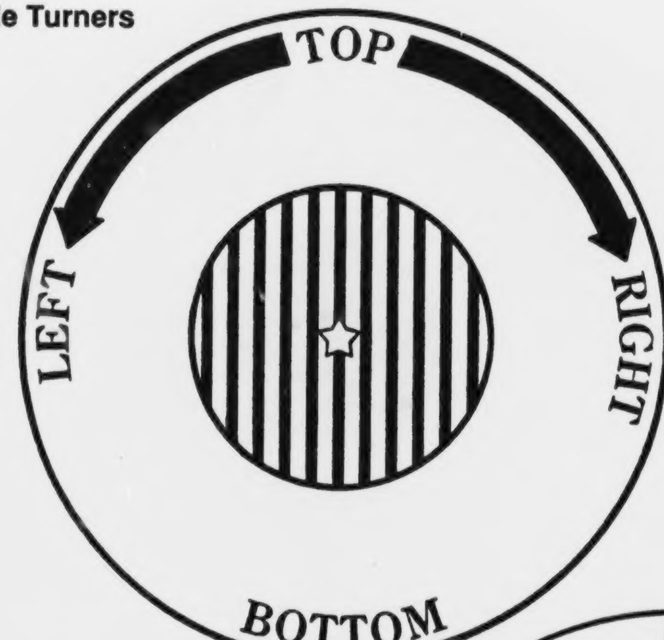
   Students should then enter a RIGHT or LEFT turn command followed by that number. For example, if they turned the triangle to the right 90 degrees, they would enter the command RIGHT 90 or RT 90.

   As students become more sophisticated Logo users, add 30, 60, 120, 150, 210, 240, 300, and 330 degree markers to Turtle Turner 2.

2. *Variation with large protractor.* In order for students to understand how to turn the turtle, they need a simple understanding of angles. To help them learn to estimate angles, you could reproduce the large protractor on the following pages. (Add 90 degrees when putting the two pages together.) Several large protractors could be mounted on cardboard and laminated for students to use and/or any clear plastic protractor could be shown on your overhead projector. The magnification is usually large enough so that everyone can see. You can use the large protractor to illustrate simple turns; start with 90 degree turns, and then show 45 degree turns. Actually draw a figure to represent the Logo Turtle, mark off a 90 degree turn, and then rotate the turtle until it has turned the 90 degrees. After several different examples, kids can quickly judge the turtle's rotation. By using 90 degrees as a reference point, they start to visualize the size of angles.

Handout

Turtle Turners

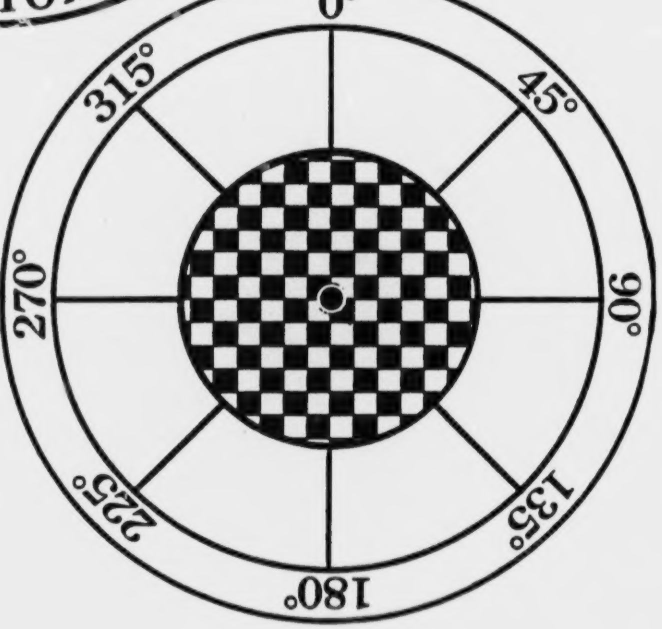


Pattern for Turtle Turner 1

(Teaches turtle directionality to beginning Logo users.)

Pattern for Turtle Turner 2

(Helps students estimate degrees for right and left turns.)



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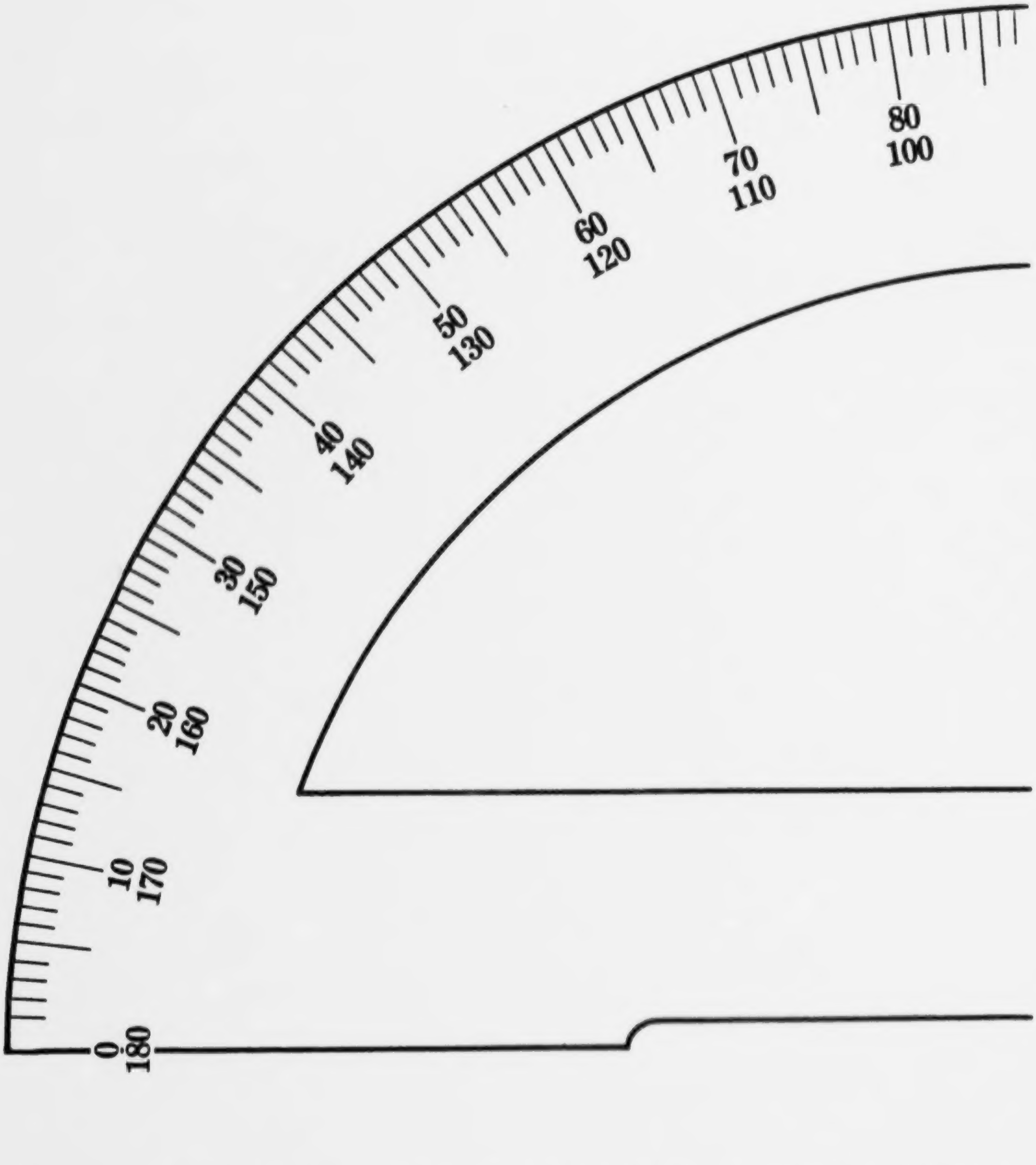
Handout

Large Protractor



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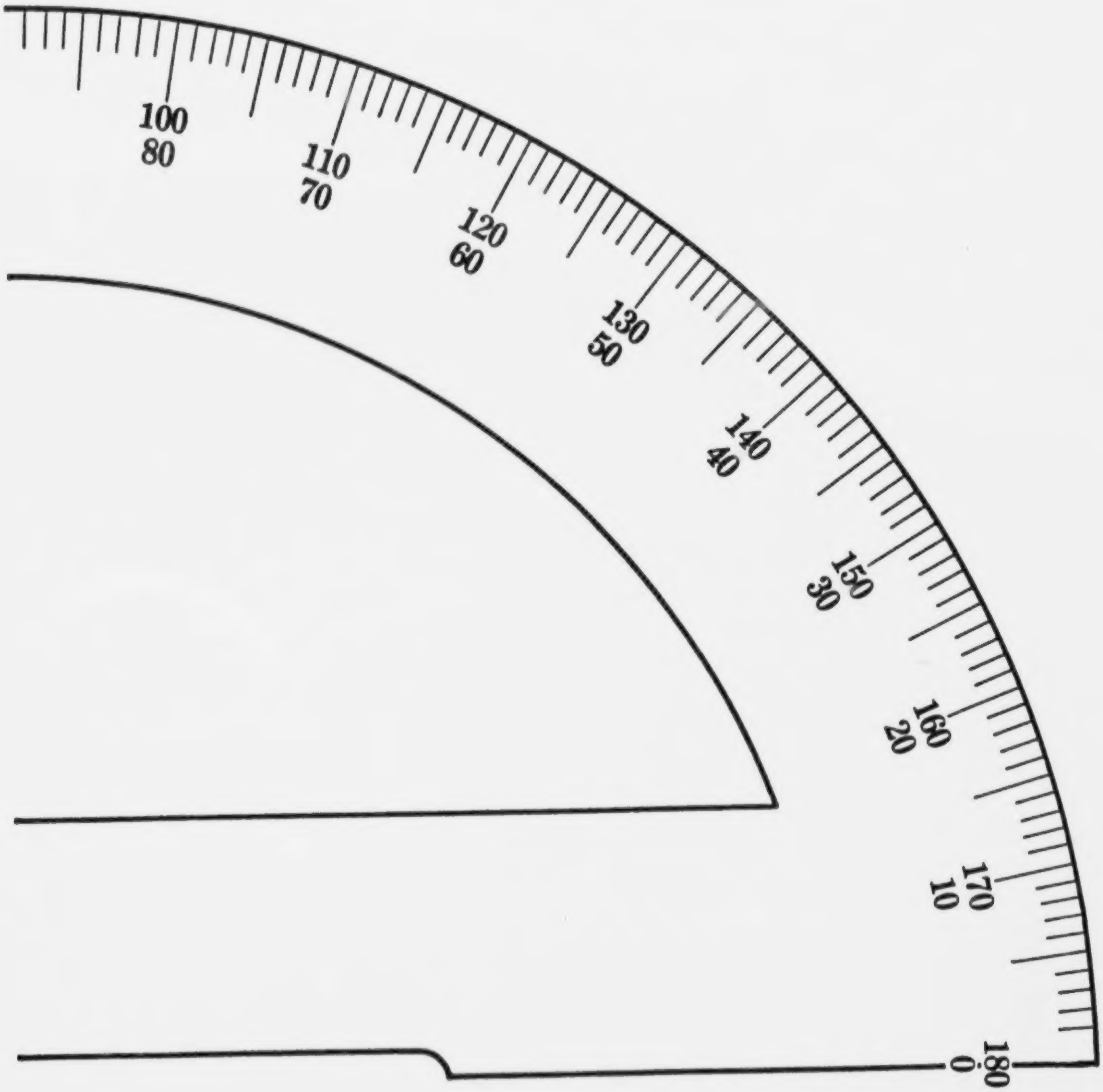
Handout

Large Protractor



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Activity

Building a Floor Grid

Objective

A floor grid is an oversized replica of the Logo screen that is assembled on the floor. Students use basic turtle graphics commands such as FORWARD, BACK, LEFT, RIGHT, and so on, to move themselves about the grid. By acting out these commands in the same way as the screen turtle, students can better understand turtle movement and directionality.

Grade Level

Grades 1–6 (The grid can be used with several activities.)

Time

30 minutes or longer

Materials

Masking tape, a magic marker, and sheets of 8 1/2" x 11" lightweight cardboard

Procedure

Use masking tape to mark off a floor-sized grid in 12-inch squares. Ideally, the grid should have the same dimensions as the first quadrant of your Logo screen. (For Apple, Krell, and Terrapin Logo, the measurements would be 12 by 14 feet. For Commodore Logo, the measurements would be 14 by 16 feet.) If your classroom is too small to accommodate these dimensions, mark off as many blocks as the floor allows. If you have a larger classroom, you might want to make the grid even bigger so that students have more room to move about.

On one of the sheets of cardboard, write HOME with a magic marker. Tape this sheet in the bottom left-hand corner of your floor grid.

Have each square of the grid represent 10 turtle steps . (If you are working with very young students, it might be easier to have each square of the grid represent one step instead of 10.) Starting with zero and counting by tens, number the remaining sheets of cardboard to correspond to the dimensions of your screen grid. For example, if your grid is 12 by 14 feet, you would write the numbers 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, and 110 on separate sheets of cardboard to correspond to the 12-foot side (the *y* axis) and the numbers 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, and 130 on sheets of cardboard to correspond to the 14-foot side (the *x* axis).

Starting from HOME (0,0), tape the numbered cardboard sheets in order along the left side and bottom of your grid.

Using the grid. Floor grids are useful for demonstrating how to make shapes, such as squares, rectangles, and triangles on the Logo screen. Student volunteers can walk through the steps, using Logo commands, and then transfer the commands to the computer.

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For example, to make a 40-by-40 turtle-step square, the student would execute the following commands on the floor grid: FD 40 (or four grid blocks), RT 90, FD 40, RT 90, FD 40, RT 90, FD 40, RT 90. Children can then enter these commands into the computer to make a square.

Variations

1. You can easily adapt the popular game Warmer or Cooler for use with the floor grid. The game can also be played on the computer (see later activities in this section). To play a simple Logo floor grid version of Warmer or Cooler, secretly write down the grid location of an imaginary object. A student stands at the HOME position. He or she can move five times in search of the hidden object. All moves must be specified in Logo command terms. After each move, tell the student whether he or she is "warmer" or "cooler" (closer to or farther from the object).

   If the student fails to find the object after five moves, another student repeats the exercise, starting from the HOME position.

   The first student to find the object gets to "hide" the next object, etc.

2. Instead of using a floor grid, the idea of making shapes on a grid could also be introduced for younger students by using geoboards and rubberbands. Designating a home peg and then counting pegs and direction on the geoboard would give children additional experience of a manageable size and would allow them to see the completed shape.

Activity

Logo Twister

Objective	To allow students to practice Logo commands such as turning right and left, following directions, and understanding angle measurements
Grade Level	Grades 1–4
Time	Variable—20–30 minutes per session
Materials	Floor grid, "Spinner for Logo Twister Activity" (pattern on the following page), brass fastener

Procedure

To play Logo Twister, first cut out the Logo Twister spinner and pointer on the following page. Laminate both pieces. Join the end of the pointer and the center of the spinner with a brass fastener.

Next designate one student to spin the spinner. Place four other students in the center of the floor grid, each facing a different side of the grid. Finally, tell the student with the spinner to spin it. Each player follows the command indicated by the pointer. For example, if the pointer points to RIGHT FOOT FD 10, each student places his or her right foot one block forward, leaving the other foot where it was from the last turn.

If a student loses his or her balance or follows the command incorrectly (turning left instead of right, for example), he or she is "out." If a player runs out of room on the floor grid, he or she skips that turn. Eventually, two or more players might land on the same square. In this case, they must try to share the space in the square without losing their balance. No pushing allowed!

Play continues in this manner until the last player is left on the floor grid. The winner becomes the new spinner, and the game starts over.

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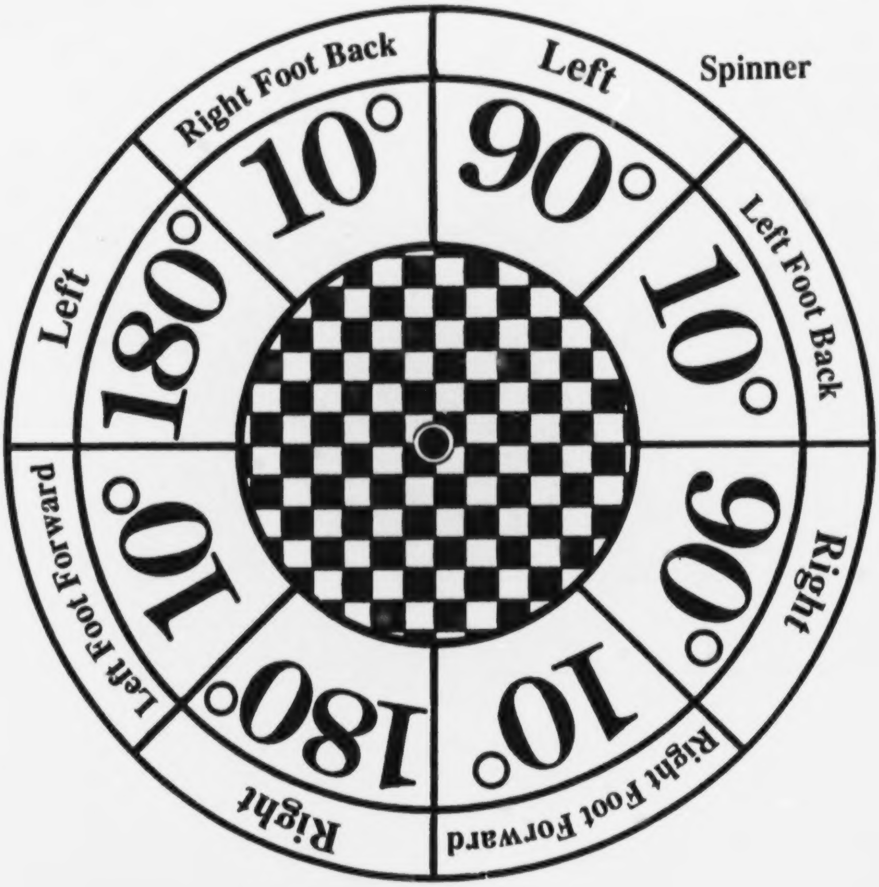
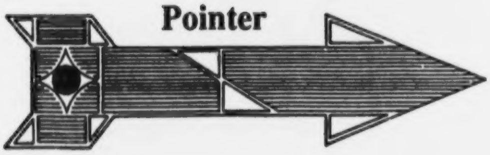
Handout

Spinner for Logo Twister Activity





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Activity

Logo Hit-the-Spot

Objective

This game may be played either on the floor grid or on computer. The floor grid version allows students to act out commands in the same way they will be programming the Logo turtle at their computers. It may be helpful to first play the game with the grid, then move to computers.

Grade Level

Grades 3–6

Time

Variable—20–30 minutes per session

Materials

Floor grid, program listing (see following page)

Procedure

To play the game using the floor grid, use a blindfolded student in place of the Logo Turtle. Let a student select a target square. Position the blindfolded student on a starting point a few feet from the square. Turn the human turtle around a few times to disorient her or him. Ask the other students to figure out and write down what single command (left or right and its degrees) and single distance command (forward or back and its degrees) would move the human turtle to the target square. Have students call out their commands, one at a time, for the blindfolded child to follow.

To play the game on computers, use the appropriate program listing on the following page. Type in the listing *exactly* as shown, save on a disk, and load into students' computers. Be sure to follow the correct version for your Logo program. (Note that Terrapin Logo uses the MIT version.)

The program places a box and the turtle at random on the screen. Students use single keystroke commands to move the turtle inside the box. These single keystroke commands are programmed into the computer by the CRAWL procedure as listed on the program directions—the CRAWL procedure changes regular Logo commands into single keystroke commands. The students type F to move the turtle 10 steps forward, B to move 10 steps back, L to turn left 15 degrees, and R to turn right 15 degrees.

To begin the game, the students type in START and press RETURN or ENTER. START is the master procedure. After clearing the screen, START calls upon the PLACEBOX procedure to draw a box somewhere and record the coordinates (x and y) of the box's lower left corner in the computer's memory. PLACETURTLE then positions the turtle at a random location with a random heading.

CRAWL contains instructions to change regular Logo commands into single keystroke commands (a procedure called INSTANT). The procedure also contains a CHECK to see if the turtle is in the box. If it is, the computer prints, "You Win!" on the bottom of the screen.

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Handout

Program Listing for Hit-the-Spot

Follow the steps for typing in the procedures for "Hit-the-Spot."

1. Type in the version of the START procedure for your Logo program.

MIT and Apple Versions:

```
TO START
CLEARTEXT
HOME CLEARSCREEN
PLACEBOX
PLACETURTLE
CRAWL
END
```

TI Version:

```
TO START
TELL TURTLE
HOME CLEARSCREEN
PLACEBOX
PLACETURTLE
CRAWL
END
```

2. Type in the BOX procedure exactly as shown.

All Versions:

```
TO BOX
REPEAT 4 (FD 25 RT 90)
END
```

3. Type in the version of the PLACEBOX procedure for your Logo program.

MIT Version:

```
TO PLACEBOX
RANDOMIZE
PENUP
SETX (110-RANDOM 240)
SETY (90-RANDOM 160)
PENDOWN
BOX
PENUP
MAKE "X XCOR
MAKE "Y YCOR
HOME PENDOWN
END
```

TI Version:

```
TO PLACEBOX
PENUP
SX (90-20*RANDOM)
SY (45-10*RANDOM)
PENDOWN
BOX
PENUP
MAKE "X XCOR
MAKE "Y YCOR
HOME
PENDOWN
END
```

Apple Version: Omit the word RANDOMIZE from the MIT PLACEBOX version.

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4. Type in the version of the PLACETURTLE procedure for your Logo program.

MIT Version:

```
TO PLACETURTLE
PENUP
RANDOMIZE
SETX (110-RANDOM 240)
SETY (90-RANDOM 160)
SETHEADING RANDOM 360
END
```

TI Version:

```
TO PLACETURTLE
PENUP
SX (90–20*RANDOM)
SY (45–10*RANDOM)
SET HEADING 40*RANDOM
PENDOWN
END
```

Apple Version: Omit the word RANDOMIZE from the MIT PLACETURTLE version.

5. Type in the version of the CRAWL procedure for your Logo program.

MIT and TI Versions:

```
TO CRAWL
MAKE "KEY RC
IF :KEY = "F FORWARD 10
IF :KEY = "B BACK 10
IF :KEY = "L LEFT 15
IF :KEY = "R RIGHT 15
MAKE "IN.BOX CHECK
IF :IN.BOX? = TRUE PRINT [YOU WIN!] STOP
CRAWL
END
```

Apple Version:

```
TO CRAWL
MAKE "KEY RC
IF :KEY = "F [FORWARD 10]
IF :KEY = "B [BACK 10]
IF :KEY = "L [LEFT 15]
IF :KEY = "R [RIGHT 15]
MAKE "IN.BOX CHECK
IF :IN.BOX? = "TRUE [PRINT [YOU WIN!] STOP]
CRAWL
END
```

6. Type in the version of the CHECK procedure for your Logo program.

MIT AND TI Versions:

```
TO CHECK
IF (XCOR > :X+25) OUTPUT "FALSE
IF (XCOR < :X) OUTPUT "FALSE
IF (YCOR > :Y+25) OUTPUT "FALSE
IF (YCOR < :Y) OUTPUT "FALSE
OUTPUT "TRUE
END
```

Apple Version:

```
TO CHECK
IF (XCOR > :X+25) [OUTPUT "FALSE]
IF (XCOR < :X) [OUTPUT "FALSE]
IF (YCOR > :Y+25) [OUTPUT "FALSE]
IF (YCOR < :Y) [OUTPUT "FALSE]
OUTPUT "TRUE
END
```

Variations: 1. To make the floor grid game more challenging, play Floor Golf. Students must negotiate a human turtle through a course made of 18 masking-tape squares (holes) on a "par" basis.

2. To make the computer game more challenging, reduce the size of the box. Do this by entering a smaller FD input number in the BOX procedure. Enter the same number in place of the existing number in the CHECK procedure.

Activity

Logo Warmer or Cooler

Objective

This game may be played either on the floor grid or on computer. In the floor grid version of the game, teams of students try to find a secret location, based on feedback from other students.

Grade Level

Grades 4–6

Time

Variable—15–30 minutes per session

Materials

Floor grid, blindfold for grid version, program listing (see following page)

Procedure

To play the game using the floor grid, pick a team of three or more students to be searchers. The searchers leave the room while the rest of the class selects a point on the floor to serve as the secret target. When the searchers return, they blindfold one of their members.

The unblindfolded searchers give turtle commands for their blindfolded team member to follow. After each command, the class responds with "warmer" or "cooler," depending on whether the blindfolded turtle has moved closer to or further from the secret location.

When the searchers discover the secret location, send out a new team of students to be searchers and start the game over. Keep a record of how many commands each team used to find the spot. The winner is the team with the least amount of commands.

To play the game on the computer, type in the appropriate program listing, save on a disk, and load into students' computers. START2, the main procedure, uses SETPOINT to select a secret location and PLACETURTLE to give the turtle a random location and heading. DISTANCE calculates the distance between the turtle and the secret location. HUNT accepts Logo turn and movement commands and continually checks to see if the turtle is coming closer to the secret location. The computer generates "Warmer" or "Cooler" messages depending on whether the turtle is closer to or farther from the target.

The program is not very "bullet-proof," however. If the student types FD45 instead of FD 45, the program stops and generates an error message. To resume the activity after an error message, students must type in HUNT. As students play Warmer or Cooler, watch for inward spiral patterns as the turtle closes in on its target.

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Handout

Program Listing for Warmer or Cooler

Follow the steps for typing in the procedures for Warmer or Cooler.

1. Type in the version of the START2 procedure for your Logo program.

MIT and Apple Versions:

```
TO START2
CLEARTEXT
HOME CLEARSCREEN
SETPOINT
PLACETURTLE
MAKE “D DISTANCE:X:Y
HUNT
END
```

TI Version:

```
TO START2
TELL TURTLE
HOME CLEARSCREEN
SETPOINT
PLACETURTLE
MAKE “D DISTANCE:X:Y
HUNT
END
```

2. Type in the version of the DISTANCE procedure for your Logo program.

MIT and Apple Versions:

```
TO DISTANCE:X:Y
MAKE “X.SQUARED (XCOR-:X)*(XCOR-:X)
MAKE “Y.SQUARED (YCOR-:Y)*(YCOR-:Y)
MAKE “HOWFAR SQRT (:X.SQUARED + :Y.SQUARED)
OUTPUT :HOWFAR
END
```

TI Version:

```
TO DISTANCE:X:Y
MAKE “X.SQUARED (XCOR-:X)*(XCOR-:X)
MAKE “Y.SQUARED (YCOR-:Y)*(YCOR-:Y)
OUTPUT (:X.SQUARED + :Y.SQUARED)
END
```

3. Type in the version of the SETPOINT procedure for your Logo program.

MIT Version:

```
TO SETPOINT
RANDOMIZE
MAKE “X (110-RANDOM 240)
MAKE “Y (90-RANDOM 160)
END
```

TI Version:

```
TO SETPOINT
MAKE “X (90–20*RANDOM)
MAKE “Y (45–10*RANDOM)
END
```

Apple Version: Omit the word RANDOMIZE from the MIT version.

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4. Type in the version of the HUNT for your Logo program.

MIT and TI Versions:

```
TO HUNT
RUN REQUEST
MAKE "D1 DISTANCE:X:Y
IF :D1 < 10 PRINT [YOU GOT IT! ]STOP
IF "D-:D1=0 PRINT [NO TEMPERATURE CHANGE]
IF :D-:D < 0 PRINT [YOU'RE GETTING COOLER!]
IF :D-:D > 0 PRINT [YOU'RE GETTING WARMER!]
PRINT[ ]
MAKE "D:D1
HUNT
END
```

Apple Version:

```
TO HUNT
RUN READLIST
MAKE "D1 DISTANCE:X:Y
IF :D1 < 10 [PRINT [YOU GOT IT!] STOP]
IF "D-:D1=0 [PRINT [NO TEMPERATURE CHANGE]]
IF :D-:D < 0 [PRINT [YOU'RE GETTING COOLER!]]
IF :D-:D > 0 [PRINT [YOU'RE GETTING WARMER!]]
PRINT[ ]
MAKE "D:D1
HUNT
END
```

5. Type in the PLACETURTLE procedure from the Logo Hit-the-Spot listing in the previous activity.

Variation: Place the secret location in a maze or city map transparency taped to the screen so that the turtle is confined to streets or paths.

Resources

Bakke, T.; Campbell, E.; Carr, N.; DuBois, P.; Eaton, M.; Kelley, B.; Reller, D.; Schubert, J.; and Wolman, J. 1985. *IDEAS for equitable computer learning*. Palo Alto, CA: American Institutes for Research.

IDEAS is designed to help educators improve computer learning opportunities for all students. This packet of materials includes strategies to counteract problem areas in computer education, a computer survey, a self-assessment checklist for teacher bias, and a bibliography of references on gender equity, computer education, and acceptance and use of computers by females.

Bright, G. 1987. *Microcomputer applications in the elementary classroom: A guide for teachers*. Boston: Allyn and Bacon.

This basic book provides general descriptions of software for drill and practice, tutorials, games, simulations, error diagnosis, and problem solving suitable for use in the elementary classroom. The primary audience for the book is elementary teachers who have had some experience, but have no particular expertise with microcomputers. In addition to the software descriptions, the book also includes a chapter on evaluating instructional software.

Concoran, A. 1989. "Software that helps develop critical and analytical math skills." *Electronic Learning* 9, no. 1: 50–52.

This article describes a number of software programs for grades K–12 that foster the following: critical thinking through the use of manipulatives, an analytical approach to problem solving, understanding through visual presentation of mathematical principles, and understanding of real-world applications of mathematical skills and thinking.

Erickson, T. 1986. *Off and running: The computer off-line activities book.* Berkeley: University of California, Lawrence Hall of Science.

Off and running was developed to encourage minority and female interest in computers, math-based fields of study, and math-related careers. The content of the book includes on-line and off-line activities that teach computer concepts and skills. Activity themes focus on learning programming skills, cooperative learning, and equity in computer usage. This book has coupled excellent educational materials with strategies to promote equity. Content is suitable for grades 5–12.

Hanson, V. P., and Zweng, M. J., eds. 1984. *Computers in mathematics education.* Reston, VA: National Council of Teachers of Mathematics.

This 1984 yearbook was developed by the National Council of Teachers of Mathematics to help teachers integrate computers into the mathematics education program in grades K–12. Issues involved in using the computer as a teaching aid are discussed.

Kreinberg, N., ed. 1977. *I'm madly in love with electricity and other comments about their work by women in science and engineering*. Berkeley: University of California, Lawrence Hall of Science.

This interesting and inspiring book includes selected comments about their work from women scientists, engineers and mathematicians. Comments are organized into sections about careers in math, engineering, physics, astronomy, chemistry, and life sciences. Suitable for upper elementary students.

Kreinberg, N.; Alper, L.; and Joseph, H. 1985. "Computers and children: Where are the girls?" *PTA Today* 10, no. 5: 13–15.

This informative article explains the importance of computer education and how parent groups may support teacher and school efforts for developing a quality computer education program. The article also lists resources for computer education programs.

Kull, J., and Cohen, B. 1989. "Pre-Logo games." *Computing Teacher* 17, no. 1: 37–43.

This article describes interesting Logo games to help young students master Logo commands before they begin working with computers. The four games—Turtle Aerobics, Feed the Turtle, Blind Turtle, and Geoboard Turtle—are suitable to assist children in grades K–6 in developing problem-solving and spatial orientation skills. In addition, two of the games offer cooperative learning experiences.

Lockheed, M. E., and Frankt, S. B. 1984. "Sex equity: Increasing girls' use of computers." *Computing Teacher* 11, no. 7: 16–18.

This article explains gender inequities in computer education and suggests four changes for classrooms and curricula that would encourage increased female participation.

Miller, I. 1984. "How schools become computer literate: And guidelines on how to evaluate educational software." *Popular Computing* 3, no. 13: 22–23, 26–28.

This article includes a set of recommendations for school computer programs and guidelines for evaluating educational software.

Moore, M. 1985. *Logo discoveries: Investigating recursive.* Palo Alto, CA: Creative Publications.

Contains reproducible black line masters of Logo activities suitable for advanced upper grade students. Most of the activities are self-directed.

Moore, M. 1984. *Logo discoveries.* Palo Alto, CA: Creative Publications.

This workbook contains reproducible black line masters of Logo activities suitable for elementary students with little or no Logo experience or background. The activities contain adequate directions, so that most students will be able to follow them on their own with little teacher assistance.

Schubert, J. 1986. "Gender equity in computer learning." *Theory into Practice* 25, no. 4: 267–75.

This article is an excellent resource for background information on gender equity in computer learning. Topics discussed include inequities, the role of school policy, selecting software, strategies for encouraging girls' interest in computers, the role of family and peers, and available resources.

Torgerson, S.; Kriley, M.; and Stone, J. 1984. *Logo in the classroom.* Eugene: University of Oregon, International Council for Computers in Education.

A teacher's guide for structured Logo lessons with a large number of student assignments and teaching aids such as keyboard diagrams, command charts, and student activity pages for duplication. Designed for use with Terrapin/Krell, Apple, Atari, TI, and Color Logo implementations.

Watt, D. 1984. "Update on Logo." *Popular Computing* 3, no. 12: 66–69.

In the past, Logo has primarily been advertised as a programming language that users discover on their own. Recent research has shown that to use

Logo effectively, teachers must thoroughly understand Logo well enough to encourage and guide students effectively. This reference contains a list of Logo software and resource materials that the classroom teacher will find helpful.

Zukas, W.; Berk, L.; and Martin, J. 1980. "Teaching fourth and fifth graders about computers." *Arithmetic Teacher* 28, no. 2: 24–27.

This article describes a series of nine lessons suitable for teaching fourth and fifth graders how computers work and allowing students to complete simple BASIC programs. Lessons one and two of the series, which develop the concepts of input and output, are also suitable for second and third graders.

Improving Spatial Visualization Skills

Spatial visualization involves the visual imagery of objects as they are rotated, reflected, and/or translated; in other words, the mental manipulation of objects and their properties. Although the results are not entirely consistent, many investigators have found that junior high and high school boys perform better than girls on visual-spatial measures. The magnitude of this difference varies according to many factors, including students' personality characteristics, previous experience with spatial activities, and the particular test given. Evidence on how spatial visualization skills affect mathematics achievement is mixed, but many investigators believe that increased training and early experience with spatial visualization can help girls, especially in geometry.

- Fennema and Ayer (1984) concluded that if spatial visualization skills do affect the learning of mathematics, the influence must be extremely subtle; however, other researchers have found strong relationships between spatial skills and mathematics achievement test scores. (Stage et al. 1985)

- Relatively large sex differences have been found on a test measuring the rotation of objects in three-dimensional space. (Sanders et al., cited in Chipman and Wilson 1985)

- Exposure to different toys and recreational activities has been linked to sex differences in spatial skills (Stage et al. 1985). Math readiness is linked to preschool games and toys (blocks, construction sets, cars, tools, etc.) that lead to an understanding of shapes and how things work. Males tend to have had more experience with these types of toys than females have. (Grayson and Martin 1988)

- There is much evidence that spatial visualization skills can be trained (Stage et al. 1985); yet this type of training is not usually made a part of the mathematics curriculum. (Fox 1981)

- Spatial visualization skills that require students to select three-dimensional shapes that would be formed by folding two-dimensional shapes have been found to be strongly related to mathematics achievement. (Chipman and Wilson 1985)

The activities on the following pages are designed to give all students, but especially female students, some of the practice and experience they need to sharpen their spatial visualization skills. It is important to begin training girls at an early age, while they are still performing on a par with boys.

Strategies

The components of spatial visualization skills include memory of shapes, figure completion, mental rotation of objects, finding hidden shapes, and the creation of three-dimensional objects from two-dimensional patterns. The first six strategies below, which will allow students to practice each of these skills, were suggested in Blackwell's *Spatial encounters* workbook (see resource list following this section).

1. To help with memory of shapes, let students try to draw familiar objects from memory or look at a picture and then try to remember the exact details of its shapes.

2. To help with figure completion skills, encourage students to work jigsaw puzzles or visualize shapes in clouds.

3. To help with mental rotation of objects, students can make stick figures of geometric shapes with Tinkertoys or toothpicks and observe how figures look when turned around.

4. To help with spatial memory and rotation, let students practice visualizing what is behind them. Have them make a sketch and then check. Also, studying a single picture and then trying to draw it as if it had been rotated 90 to 180 degrees is a good exercise.

5. To help with the ability to locate hidden shapes, students can try to distinguish geometric shapes in simple pictures or even the clouds. They can also look for common shapes in everyday objects and in stylized artwork.

6. To help with the ability to go from two-dimensional to three-dimensional space, students can assemble models of toys.

7. Use a copy of Blackwell's *Spatial encounters* to allow students to practice the various component skills that constitute spatial visualization.

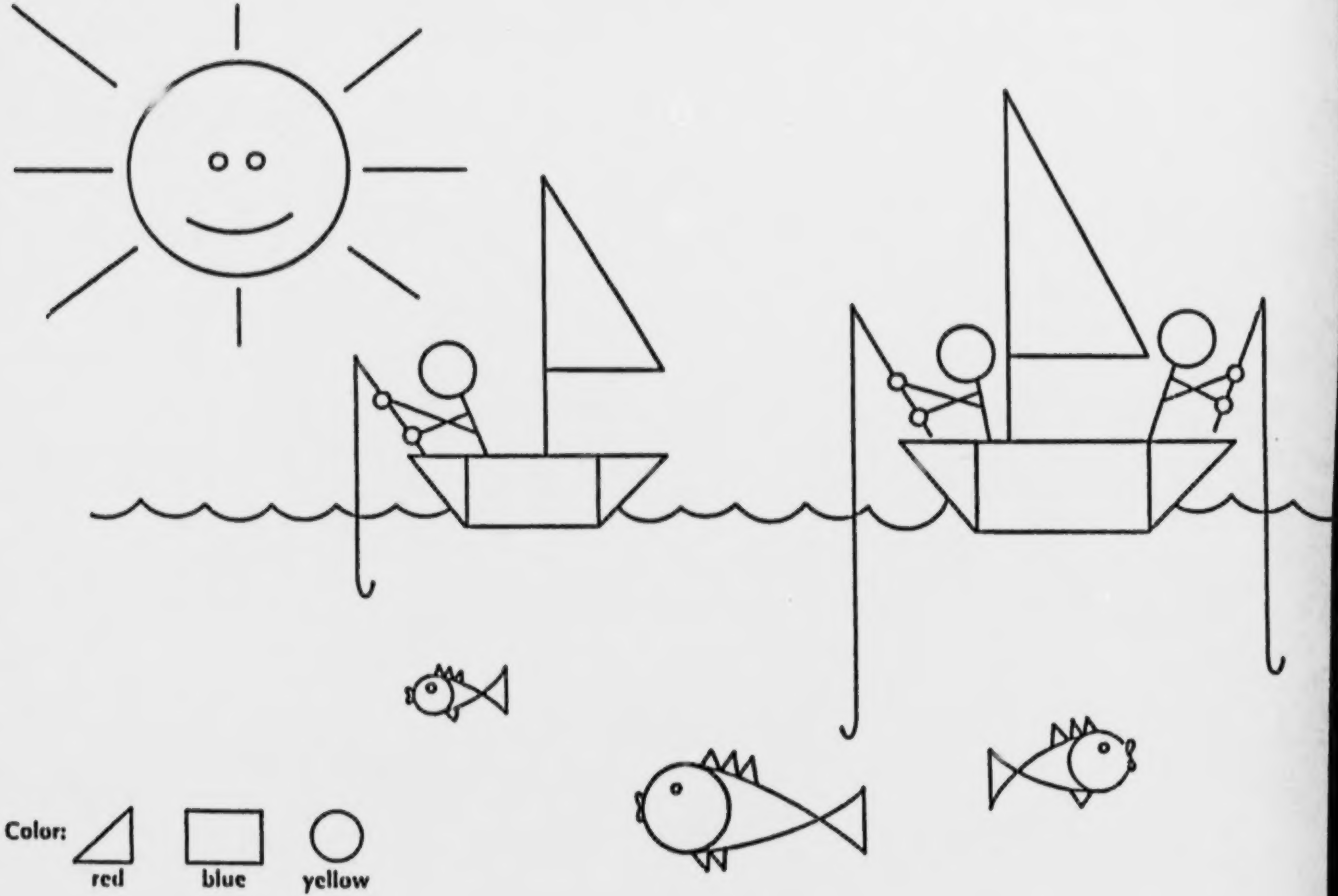
8. Especially in the early elementary years, make sure that the girls in your classes play with blocks, legos, and other manipulative building toys as much as the boys do. To encourage girls to play with these toys, model that behavior.

9. In high school geometry, students organize and structure their spatial experiences. Few elementary math curricula stress informal geometry. Research findings indicate that both elementary and pre-geometry high school students exhibit many misconceptions about shapes. The article by Burger (see resource list) provides several suggestions for activities that will help elementary students become familiar with informal geometry concepts and prepare them for geometry.

Activity

Fishing for a Shape

Objective	To give students practice identifying three basic geometric shapes: triangle, rectangle, and circle
Grade Level	Grades 1–2 (see variation for grades 3–6)
Time	15 minutes
Materials	Geometric picture on the following page
Procedure	Duplicate one copy of the following page for each student. Students are to find, identify, and color each shape in the picture according to the color key in the corner. This can be used as an independent practice activity after a lesson on geometric shapes or as a review activity. Many art books show pictures as compilations of shapes, and you might use those for additional pictures.
Variation	Depending on the ability of students, have them design their own pictures using only circles, only rectangles, only triangles, or any combinations.



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Activity

Closed Curve Art

Objective

To draw and understand the definition of a closed curve; to become aware of symetrical patterns

Grade Level

Grades 3–6

Time

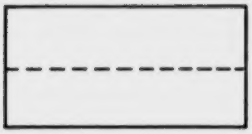
15 minutes

Materials

One sheet of 8 1/2" x 11" white or colored construction paper, scissors for each student

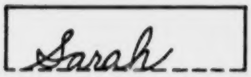
Procedure

Have each student fold his or her paper in half from the 11" side to the 11" side:

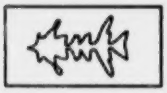


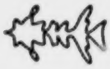
Keeping the paper folded and the fold at the bottom,

each student should write his or her name (first or last) in very large cursive letters.



Then have the student make a cut from the left *through the fold* and continue cutting around the outside of the letters, being careful *not to cut through the fold* until he or she reaches the last letter. Then, cut through the fold.

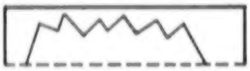




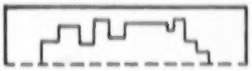
These can be decorated with markers or crayons.

Variation

Students can also draw other types of designs on their folded papers. For example:

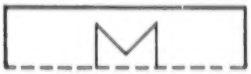


or



or

individual letters



Cut around the outside of the designs and unfold to create symmetrical multisided straight line designs.

Activity

Dice Patterns

Objective	To practice spatial visualization skills by observing and constructing a three-dimensional object
Grade Level	Grades 3–6
Time	Variable—up to 25 minutes
Materials	Heavy paper or cardstock, transparent tape or glue, scissors, several dice, copies of the dice patterns on the following pages

Procedure

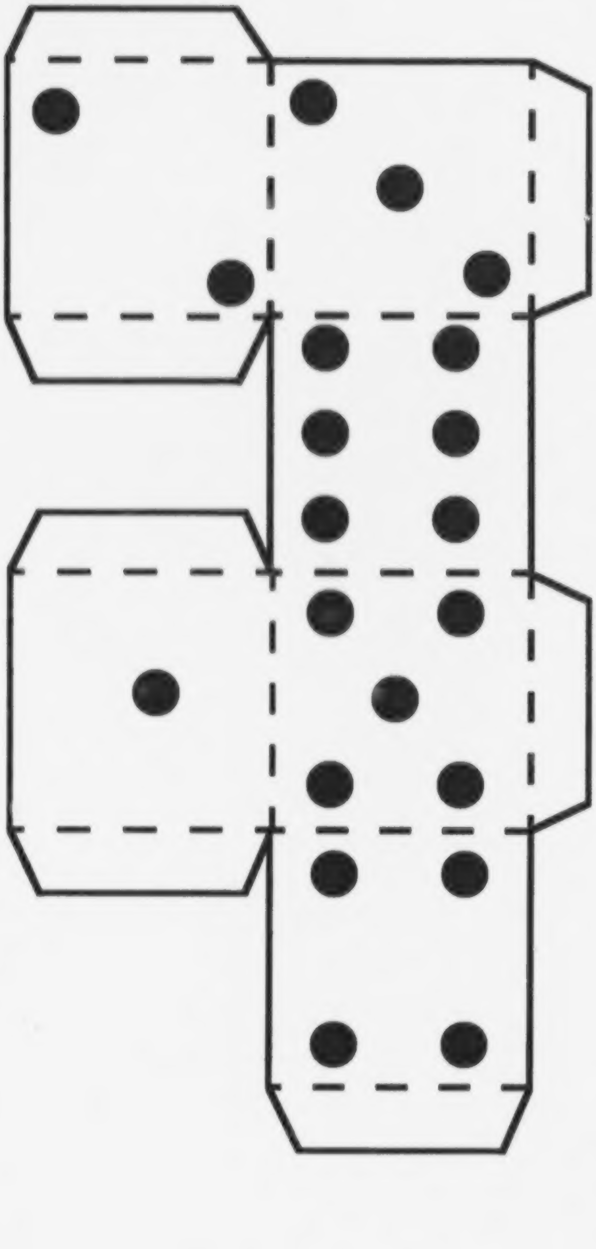
This activity may be done individually or in two- or three-person groups. Give each group of students one die and copies of the dice patterns. Ask students to observe the dice carefully. Do all of the dice have the same pattern of dots on their sides? (that is, the one opposite the six, the two opposite the five, and three opposite the four). Is there a pattern in the patterns? (opposite sides always add to seven).

After students have observed the dice, ask them to decide which of the patterns on the following pages could be cut out and folded to make a dice. Have students verify their decisions by cutting each of the patterns out of heavy paper or cardstock. The patterns should be cut on the solid outside lines, creased on all dotted lines, and shaped with the edges glued or taped at the tabs. ("E" is the only pattern that can be shaped into a cube.)

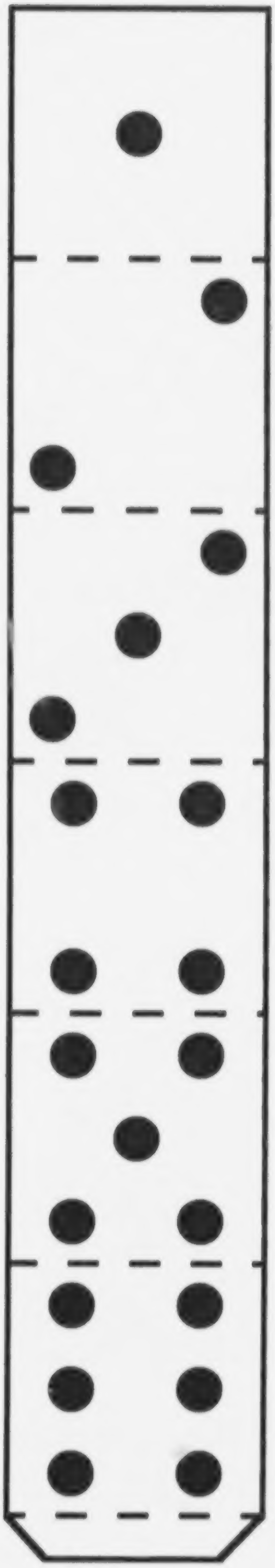
Variation

Let advanced students design their own patterns. How many different patterns can be folded into a dice with the correct number of dots on each side.

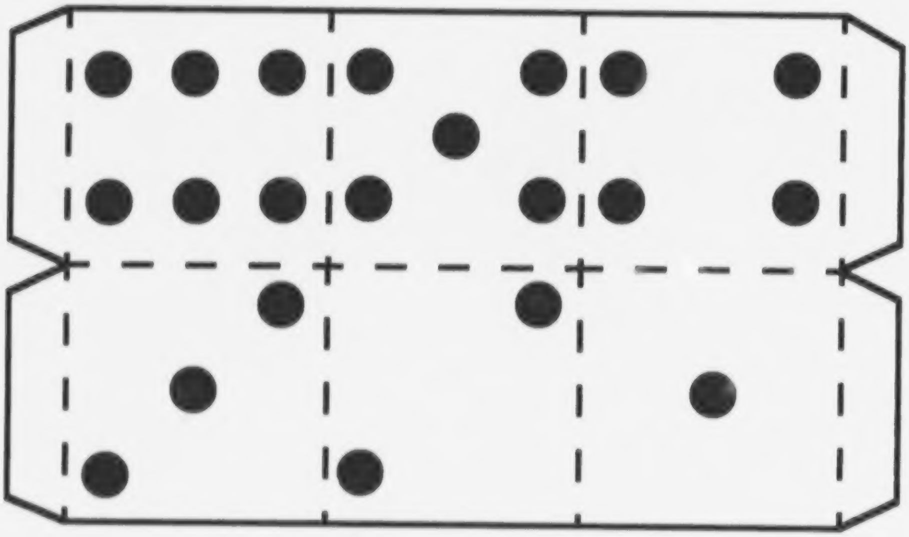
A.



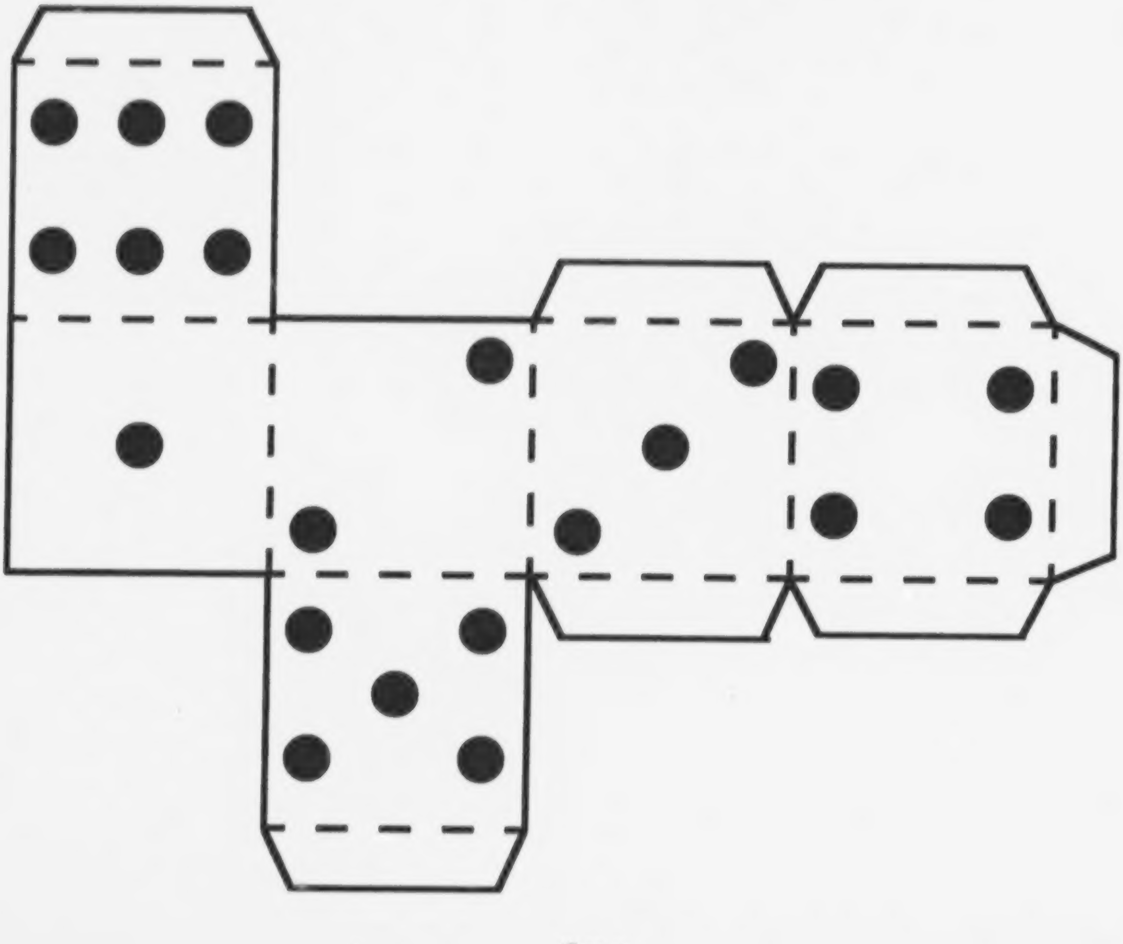
B.



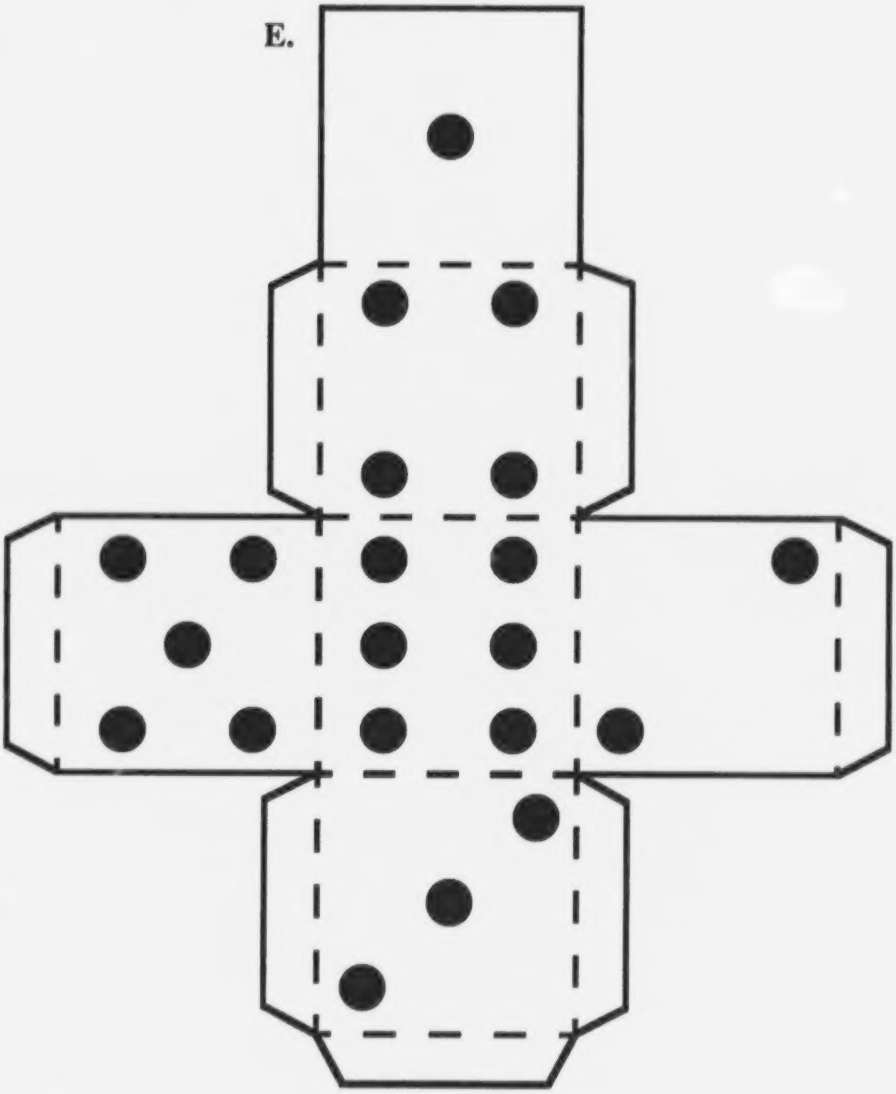
C.



D.



E.



Activity

Origami Box

Objective	To improve visualization of three-dimensional objects from two-dimensional diagrams
Grade Level	Grades 4–6
Time	20 minutes
Materials	One square piece of paper for each student (you can use wallpaper scraps), copies of the "Origami Box" diagramed instructions on the following page
Procedure	This activity may be done individually, in pairs, or in groups. Give each student or group of students a copy of the "Origami Box" instructions. Instruct each student to follow the diagrams to construct an open box by folding the square piece of paper. Demonstrate each step for students to assure more success and less frustration; however, be sure that you let your students follow the directions and complete the exercise on their own.

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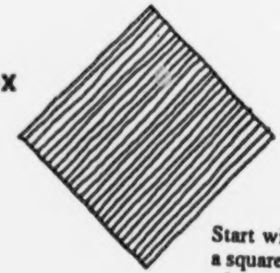
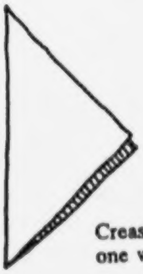
Handout

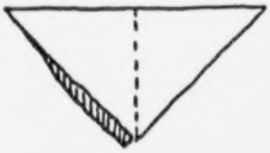
Origami Box



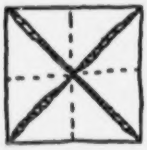
Start with a square piece of paper.



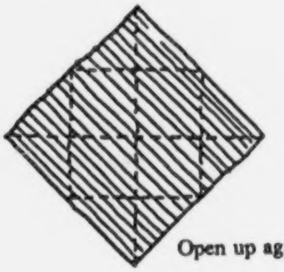
Crease it one way.



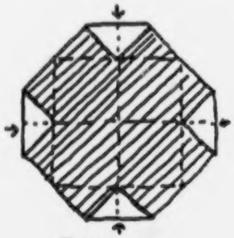
Crease it the other way.



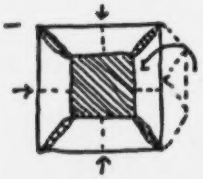
Fold all four points in to center.



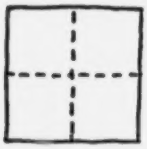
Open up again.



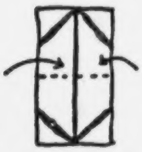
Fold in the points to the first fold line.



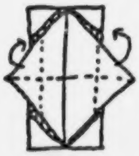
Fold in the sides where you just folded in the points—fold on the fold lines already there.



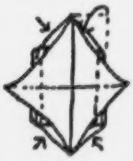
Turn it over.



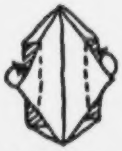
Fold right and left sides up so they meet in the center on top.



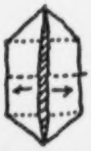
Lift those flaps up in the air.



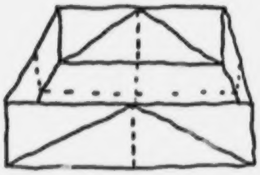
Fold all four corners up and in.



Tuck flaps to inside and flatten entire figure.



Open the center slot. Pull the two sides apart to form a box, sharpening folds as needed.



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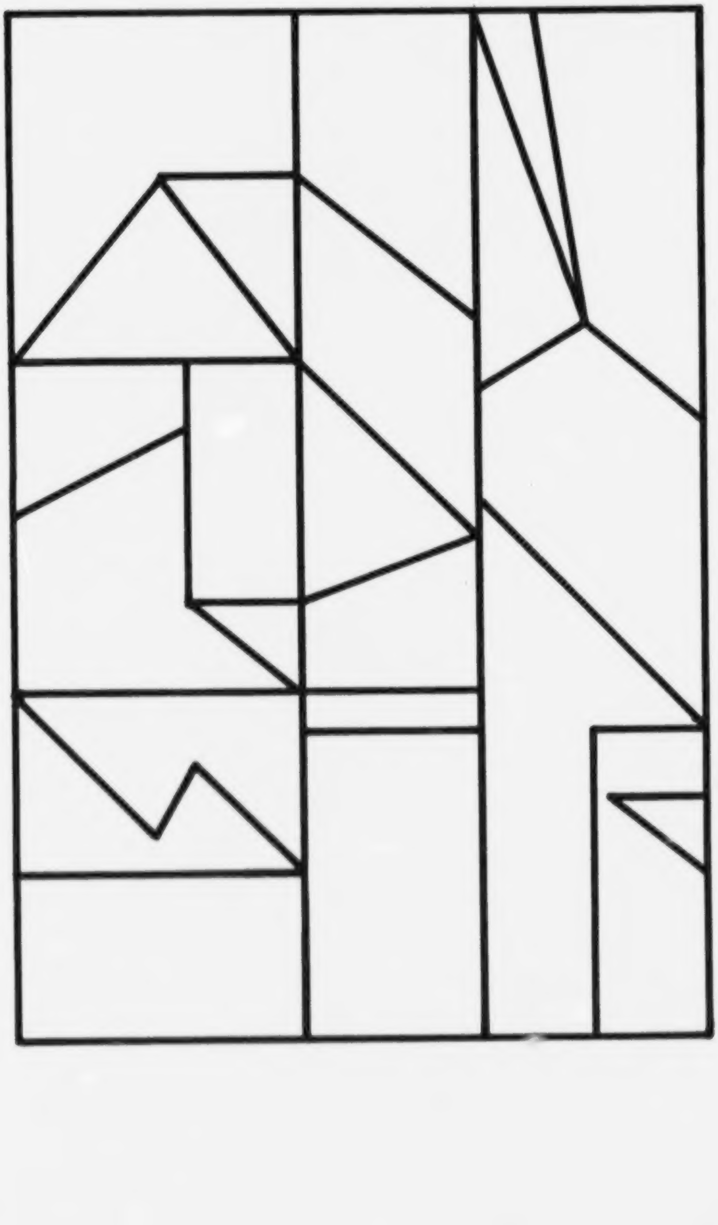
Activity

Count the Shapes

Objective	To help students discover the characteristics of single shapes
Grade Level	Grades 4–6 (See variation for grades 2–3.)
Time	20 minutes
Materials	Shapes drawing on the following page
Procedure	The figure on the following page contains a number of common shapes. Make a copy for each student. Define and discuss the properties of various shapes. Then ask students to count the numbers of triangles, quadrilaterals, and pentagons.
Variations	1. Let students draw their own puzzles and demonstrate the properties of these or other shapes. 2. *Variation for grades 2–3.* Let students color all of the triangles one color, all of the quadrilaterals a second color, and all of the pentagons a third color.



Resources

Blackwell, P. J. 1982. *Spatial encounters: Exercises in spatial awareness.* Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

A fun book for students of all ages who need to develop their spatial visualization skills. *Spatial encounters* contains a variety of games and exercises that involve figure completion, memory of shapes, and rotation. The book is particularly helpful for girls whose skills have been hampered by lack of practice.

Burger, W. F. 1985. "Geometry." *Arithmetic Teacher* 32, no. 6: 52–56.

This article describes common misconceptions students hold about shapes and suggest a number of activities to introduce them to informal geometry and strengthen their skills in analyzing and classifying shapes by their properties. The article contains an excellent bibliography of materials and activities useful in teaching informal geometry.

Crowley, M. L. 1987. "The van Hiele model for the development of geometric thought." In *Learning and teaching geometry, K–12,* edited by M. M. Lindquist, 8–12. Reston, VA: National Council of Teachers of Mathematics.

Manipulatives are used to help children understand geometric concepts in the many activities suggested in this article.

Downie, D.; Slesnick, T.; and Stenmark, J. K. 1981. *Math for girls and other problem solvers.* Berkeley: University of California, Math/Science Network.

The activities in this book encourage independent thinking and creativity in mathematics. Students and teachers are encouraged to think about problem solving in versatile ways and forms. Although this book was originally designed for females, the activities are appropriate and interesting to both boys and girls, ages 7–14.

Fraser, S., ed. 1982. *SPACES: Solving problems of access to careers in engineering and science.* Berkeley: University of California, Lawrence Hall of Science.

A collection of thirty-two classroom activities designed to stimulate students' thinking about math-related careers, develop problem-solving skills, and promote positive attitudes toward math. Activities are designed for students in grades 4–10.

Hill, J. M., ed. 1987. *Geometry for grades K–6: Readings from* Arithmetic Teacher. Reston, VA: National Council of Teachers of Mathematics.

This collection of articles and activities from the *Arithmetic Teacher* features a hands-on approach to teaching the foundation principles of geometry to students in grades K–6.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics and provide information about opportunities for women in nontraditional careers. Ultimately, the purpose of the program is to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction. Materials are suitable for grades 4–12.

Silvey, L., and Smart, J. R., eds. 1982. *Mathematics for the middle grades (5–9).* Reston, VA: National Council of Teachers of Mathematics.

This book was developed to aid teachers in promoting the mathematical development of students in grades 5–9. The three sections of the book cover critical issues in mathematics education, unique learning activities, and strategies for teaching problem solving.

Skolnick, J.; Langbort, C.; and Day, L. 1982. *How to encourage girls in math and science: Strategies for parents and educators.* Palo Alto, CA: Dale Seymour Publications.

This excellent resource examines the effect of sex-role socialization on girls' math/science skills and confidence. It explains how attitudes, parenting and teaching practices, stereotypical play activities and books, peer pressure, and career and family expectations cause girls to question their abilities in math and science, and thus hinder their development in these areas.

In addition to the summary of the socialization process, the book contains a variety of compensatory educational strategies and activities that may be used to encourage females in mathematics. These particularly focus on increasing math confidence, spatial visualization skills, and problem solving. Both parents and educators can benefit from this book.

Stenmark, J. K.; Thompson, V.; and Cossey, R. 1986. *Family math.* Berkeley: University of California, Lawrence Hall of Science.

If mathematics promotion is a goal of your teaching, *Family math* activities will help you introduce parents and children to ideas that improve their math skills and help them gain an appreciation for math. Hands-on mathematical experiences provide families an opportunity to develop problem-solving skills by using the following strategies: looking for patterns, drawing pictures, working backwards, working cooperatively with a partner, and eliminating possibilities. Spatial relationships (geometry), estimation, data interpretation (probability and statistics), and mathematical reasoning are the mathematical concepts learned from *Family math.* Materials suitable for ages 5–18.

Improving Test-Taking Skills

Although girls generally do as well as boys on tests that cover materials learned in the classroom, their performance tends to be poorer than that of boys on national math tests, such as the Scholastic Aptitude Test (SAT) or the American College Testing Program (ACT). Many educators prefer to deemphasize the use of standardized tests; however, in today's educational climate, these tests can have a great impact on students' futures. In some school systems, elementary students are tracked based on standardized test scores such as the California Achievement Test (CAT). Test scores also impact students' placement in advanced or enriched programs, entrance to particular colleges, and awards of scholarships or other forms of financial aid for postsecondary school. Thus, even as we work toward better ways of assessing student achievement, we still need to ensure that students know how to do as well as they can on standardized tests. There are some indications from research that girls may be attending to different cues and taking in too much distracting information during testing. Others hypothesize that boys may do better because they are more competitive and may be less anxious about performing under pressure.

- In results of recent national testing of high school students, boys out-scored girls on the mathematics portion of the SAT by 47 points, which represents an average score that was 10.4 percent higher for boys than for girls. On the ACT mathematics subtest, boys' average scores were 15.5 percent higher than the average scores for girls. ("Gaps persist between sexes" 1987)

- Even when the SAT is given to seventh graders, there is a large difference (35 points) favoring boys; this difference cannot be explained by differences in course-taking at school. (Fox 1981)

- Some researchers have suggested that sex differences in math scores may be due to content bias in the tests; others suggest that girls use a poorer test-taking strategy than boys do. (Dwyer 1987)

- Testing often represents a pressure-filled situation for students. Increased evaluative pressure has been found to enhance the performance of boys, but to impair the performance of girls. (Dweck and Gilliard, cited in Russo 1985)

- Slightly speeded tests which feature easy-to-hard item order favor male students more so than any other item arrangement. In one study, girls performed best when items were arranged in many small clusters of easy-to-hard order. (Plake et al. 1982)

- Female students generally experience significantly more test anxiety, as measured by the Mathematics Anxiety Rating Scale, than do boys. (Plake et al. 1982)

The following suggestions should help all students improve their test-taking skills and should provide practice that will build a foundation to assist girls in scoring better on national tests.

Strategies

1. *Vary* the format of tests; give objective math tests.
    a. Design a test supplying all the answers. Students need to work the problems to eliminate the incorrect answers.
    b. Design a matching test. This works well, especially when teaching properties in math.
    c. Design a multiple choice test. Include choices of "not here" or "none of the above" if you want to prevent guessing.
    d. Design an oral math test. This can be dictated onto a tape. In the primary grades, this can be useful for basic facts.
2. Let parents know from the beginning of the year how their child can get the most out of your math class (see the parental involvement section). Send home information about your grading procedures and how or when you schedule tests.
3. Provide frequent, mixed, cumulative reviews. Have an ongoing maintenance program for previously learned topics.
4. Cover key topics before test-taking time.
5. There is usually more than one right way to do a math problem, so accept a students' alternative procedure if it and the solution are correct.
6. Encourage students to take time to work problems out with paper and pencil.
7. Don't always push for speed in solving math problems. Quickness doesn't ensure correctness, and most good, interesting math problems require considerable time for solution.
8. Determine how many problems you *really* need on a test to test what you want to know.
9. Teach students the skills involved in test taking—examining problems for key words, using a process of elimination, etc.
10. To help students learn to solve word problems, (a) have them rewrite problems and (b) let them write their own problems for other students to solve.
11. Let students make up their own tests along with the answers. Constructing test items helps students think through the steps involved in solving problems.

12. To prepare students for standardized tests use the following strategies:

    a. Know the territory. Take important features of the test and devise ways to incorporate them into your teacher-made tests.

    b. Go slow on the easy questions. Don't speed through easy questions to save time for the hard ones. The easy questions often help students focus on procedures.

    c. Practice. Be sure students have the basic skills required on the test, and also that they understand and have practice with the test's instructions and answering format.

    d. Let students feel you're confident that they'll do well.*

13. When a standardized test contains a series of questions based on a graph or chart, students often spend too much time studying the material and may be overwhelmed by superfluous information. Tell students to first skim the graph for general content, then read the questions, then go back to the graph and look for the answers. Incorporate these types of problems in your tests to give students practice.

14. Sometimes word problems contain spelled-out numbers or values such as dozen. Students often focus only on the numerals and overlook these written-out numbers. To help them avoid these types of errors on standardized tests, provide practice word problems that feature a combination of numerals and written values.

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* Item 12 is from W. Kroen, "Make your students test savvy," in *Instructor* 96, no. 7: 66.

Activity

Practice Test

Objective	To familiarize students with the testing format and practice skills required for a specific test
Grade Level	Grades 1–6
Time	30–45 minutes for preparation, 30 minutes (variable) for activity
Materials	Practice test
Procedure	This activity requires extra time from teachers, but definitely helps students study for a standardized test. Using the test format and type of problem(s) to be tested, select two sample problems (similar, not actual test questions) from each area. Design a practice test following the exact format of the standardized test. After the practice test, it is crucial that the answers (for skill understanding) and test format (for test-taking skills) be thoroughly reviewed with students. With very young children it is especially important to go over the format and instructions many times so that their anxiety will be reduced.

Activity

Math Bowl

Objective	To review skills to be tested
Grade Level	Grades 1–6
Time	20 minutes for preparation, plus 20–30 minutes for the activity
Materials	3" x 5" cards
Procedure	Depending on the type of test—cumulative, standardized, criterion-referenced, teacher-prepared, chapter test, and so forth—select sample problems. Put each problem on a 3" x 5" card with the solution. Divide the class into teams with an equal number of students with similar abilities. Problems can be given individually (as in a spelling bee) until all members of a team have been eliminated or cooperatively whereby the team decides on the solution. This activity is easily adaptable to all levels of math, requires little work of teachers, and encourages students to review on school time, not their time!

Activity

"Test-Wiseness" Training

Objective	To teach students how to score well on standardized tests
Grade Level	Grades 4–6
Time	20 minutes per session
Materials	Copies of "Hints to Make You 'Test-Wise'" on the following page

Procedure

Test-wiseness has been defined as the capacity to use the characteristics and formats of the test and/or test-taking situation to obtain high scores—independent of knowledge about the subject matter of the test. In other words, a test-wise person can increase his or her test scores by use of a number of strategies and attention to cues that have little to do with the content of the test. The results of many studies have shown that test-wiseness can be learned, that training is not effective until students reach grade 4, and that 9–14 hours of training are best for maximum results.

Four skills have been found to produce significant improvement in the test performance of elementary school children who have had little or no previous test-taking experience with standardized achievement tests. These skills are following directions, using time wisely, guessing strategies, and answer changing. In addition, multiple choice questions allow the test-wise student to eliminate distractors by attending to cues unrelated to test content.

On the following page, some hints for students are listed that are partially based on material from a 1986 article by Benson, Urman, and Hocevar (see resource list).

Before using these hints, make sure that they are appropriate for the standardized tests you give; modify them if necessary. For example, the second hint under "Following Directions" is only appropriate if questions are allowed throughout the testing period. Some standardized tests require that no student questions be answered once the test begins. The hint, "Do not leave any question blank" (under "Using Time Wisely"), as well as all of the guessing hints are only good strategies if there is no penalty or correction for guessing.

Go through the hints with students, helping them with examples from a previous math test. You may want to have younger students practice only one strategy at a time.

For a copy of a test-wiseness curriculum manual covering the four strategies, write to Jeri Benson, Assistant Professor, Department of Measurement, Statistics, and Evaluation, University of Maryland, College Park, Maryland, 20742.

Handout

Hints to Make You "Test-Wise"

Following Directions

Read and listen carefully to directions before starting the test.

If you don't understand something about the test or how to fill it out, ask your teacher during the test.

Fill in only one answer for each question on the answer sheet.

Fill in the answer space completely.

Using Time Wisely

Know how much time you have to take the test.

First, answer all the questions you know.

Go back to the harder questions later.

Do not leave any question blank.

Guessing

Make your best guess instead of leaving a question blank.

When guessing, reread the questions carefully.

When guessing, read every option carefully.

Guess only after going through these steps.

Changing Answers

Change an answer when you know you marked it wrong.

Change an answer when another seems better.

Activity

Math Words

Objective	To write steps and solutions to problems for test review
Grade Level	Grades 3–6
Time	Variable—20–30 minutes
Materials	Problems from textbook
Procedure	Give each student a different set of problems from a specific page in the text. Instruct the student to fold a piece of paper in half (lengthwise). On the left side, the student works each problem; on the right side, she or he explains in words, how to solve the problem. Use this activity with individual students as a check for understanding or in a partner situation to help students who are having difficulty. This technique is especially effective in solving word problems, but is also helpful in breaking down understanding of the multiple steps required in math problems.

Resources

Benson, J.; Urman, H.; and Hocevar, D. 1986. "Effects of test-wiseness training and ethnicity on achievement of third- and fifth-grade students." *Measurement and Evaluation in Counseling and Development* 18, no. 4: 154–62.

This article summarizes findings from a study on math achievement after test-wiseness training. The study includes information from a test-wiseness training manual and lists a number of strategies for students.

Grassick, P. 1983. *Making the grade: How to score higher on all scholastic tests.* New York: Arco.

Includes a number of tips and strategies for test-taking.

Kroen, W. 1987. "Make your students test savvy." *Instructor* 96, no. 7: 66.

A brief article that provides several suggestions to help students become test-wise.

Margenau, J., and Sentlowitz, M. 1977. *How to study mathematics.* Reston, VA: National Council of Teachers of Mathematics.

A study guide that gives math students suggestions for developing study and test-taking skills. The guide is illustrated with cartoons to appeal to the junior high or high school student. Elementary teachers, especially those of grades 4–6, may find some tips to pass along to their students.

Part 5

Mathematics Promotion

This section of the guide contains ideas to help you promote mathematics as an important and worthwhile subject. It includes suggestions for

1. involving parents
2. working with counselors
3. working with administrators and other teachers to promote math throughout your school

Increasing Parent Involvement

Parents' attitudes and expectations for their children are probably the most important factors in determining students' own attitudes, expectations, mathematics participation, and achievement levels. We know that many parents treat boys and girls differently. We also know that it can be extremely difficult to involve some parents in their children's education.

- Parental attitudes are crucial in determining a young woman's self-concept regarding her abilities, interests and career goals. (Becker 1984; Wigfield 1983; Fox 1982)

- Girls respond more than boys to parental expectations. (Burton et al. 1985)

- Parents consider mathematics to be more important (Eccles [Parsons] et al. 1985) and more appropriate (Fox 1977) for boys than for girls; they believe math is more difficult for girls than for boys, and that girls have to work harder than boys in order to do well in math courses. (Eccles [Parsons] et al., cited in Stage et al. 1985)

- Parents of students who eventually took more than the required math classes in high school were perceived to have been more encouraging (Sherman et al., cited in Chipman and Wilson 1985); parental expectations and support frequently differentiate students who continue in math from those who do not. (Stallings 1985)

- Perceived parental encouragement was strongly related to twelfth grade math achievement, but it was not a factor at age 13 (Armstrong 1985). Sherman reported a strong relationship between parental encouragement and measures of mathematics achievement for girls, but not for boys. (Cited in Chipman and Wilson 1985)

- Support and encouragement from parents was a crucial factor in students' decisions to elect mathematics courses in high school; for girls, the influence of their fathers was greater than that of their mothers. Parents were found to have lower expectations for girls than for boys and to foster mathematical self-confidence and course-taking less for girls than for boys. (Fox 1981)

The strategies described on the following pages are designed to help you involve parents in their children's math education. Information to help modify some parental attitudes towards girls and math is also provided.

Strategies

1. As much as possible, try to communicate directly with parents about their child's accomplishment, as well as problems. Use one or more of the activities on the following pages to initiate contact with parents. Some teachers contact parents only when there is a problem. When parents understand that you are genuinely interested, they will become more involved with their child's math education.

2. Use every opportunity—letters, newsletters, phone calls, parent conferences, and school visits—to educate parents about the importance of positive math attitudes and encouragement of their children.

3. If your school sends a newsletter to parents, write a brief column to educate parents about math attitudes, and give them ideas for working with their children in mathematics. If there is no newsletter for parents, suggest one to your principal. Another alternative is to get together with other teachers and produce a flier for parents—each issue can emphasize a different subject.

4. To encourage parents to join their children in interesting and fun math activities, occasionally send home math puzzles and teasers. Some excellent sources for these are the books *Math for smarty pants* and *The I hate mathematics book* both by Burns, *Games and puzzles for elementary and middle school mathematics: Readings from the arithmetic teacher* by Smith et al. (see both books in the resource list), and individual copies of the *Arithmetic Teacher* magazine. Check the resource list from the section on problem solving for other sources. Parents and students can work cooperatively on these activities.

5. Another idea for using puzzles, games, and teasers is to go over the explanation in class, then have students teach their parents how to solve these mathematical puzzles. Obtain parental cooperation before beginning the activity. The idea here is to encourage students to master concepts by teaching them, and to let parents observe their children's level of mathematical understanding.

6. Recommend the books *Family math* by Stenmark et al. and *How to encourage girls in math and science* by Skolnick et al. to parents (see resource list). These paperbound books are filled with interesting math activities designed for parents and children.

7. If some parents are interested, but don't know how to tutor their children in math, you might want to hold a math help session for parents or a series of sessions on particular math topics you'll be covering in the coming weeks.

8. Bring interested parents (especially mothers) into the classroom to help as math aides. Enlist parents to help in special after-school tutoring sessions for students needing additional assistance.

9. Hold special "math fun" sessions for parents and students. Allow for the single parent or the child whose parents are unavailable but who could bring an older

sibling, another relative, or other adult. (See ***Family math*** by Stenmark et al. for additional information on planning and conducting these sessions. This book is listed in the resource section.)

10. Hold a math careers night (or weekend workshop) for parents. Obviously, a child in the early elementary years is not ready to plan a future career; however, it is helpful to encourage parents to begin thinking about their child's options and about the need for math. It is particularly important that parents understand that their daughters will definitely need to have a sound math background. To put together a career workshop you might work with your school counselor. Also, consult the resource list in the "Math Relevance" section of this guide for sources of information on math-related careers. The posters *When are we ever gonna have to use this?* by Saunders and *Dropping math? Say goodbye to 82 jobs* by Wiggan (see resource list in the following section on working with counselors) contain helpful information on this topic.

Activity

Letter to Parents

Objective	To establish communication with the parents of your students; to gain the support of parents by informing them of your expectations for their child
Grade Level	Grades 1–6
Time	30 minutes
Materials	Letter to parents (see "Sample Letter to Parents" on the following page)
Procedure	Develop a letter that briefly introduces you and your philosophy, informs parents about your mathematics classroom requirements, invites their involvement, and lets them know when you are available for conferences. A sample letter is presented on the following page; you can modify it to fit your needs. If you have access to a word processor, you might prefer to address each letter personally, and refer to the child by name. Send a copy of the letter home with each student early in the school year so that you gain the support of parents at the beginning of the term.
Variation	Send a series of letters throughout the year describing the student's progress and/or giving parents more specific suggestions for involving their child in math, providing encouragement, do's and dont's, etc.

Handout

Sample Letter to Parents

September 19xx

Dear Parents:

I would like to introduce myself. I am ________________, your child's _____ grade teacher. (You might make a statement here about how long you've been teaching or the length of time you've taught at this school.)

Your child's success in mathematics is very important, and our communication and support can make the difference between her/his success or failure. Working as a team, we can promote healthy and positive attitudes and habits that help your child advance one or more academic years in math.

Below, I have listed some of the requirements of grade___ math. Also listed are some suggestions that will help your child to succeed in math.

Classroom Procedure

- Homework daily—I usually require approximately ______ minutes per night.
- Tests are given frequently. Students will be informed of the test two days prior to the test date.
- Students are expected to attend class prepared with the necessary materials.

Suggestions for Helping Your Child Study Math

- Provide a special quiet place free from distractions for study.
- If possible, provide a calculator, and help your child discover the ways it can be used.
- Expect homework to be done.
- Try to keep your comments positive; give your child lots of encouragement.
- From time to time, request to see the following:
  - –An assignment notebook recording daily assignments.
  - –Homework assignments—you need not check the calculations; look for legible completion of the assignment.
  - –Quizzes and tests.

Teacher Support

- Computer grade reports will be sent home every other week.
- Tests and quizzes will be sent home with your child.
- Extra help—I am available daily before or after school by appointment.
- I am available for a parent conference ________________________ Please call the school at xxx-yyyy for an appointment.

I want to invite you to visit our classroom and to communicate with me about your child's math progress throughout the year. Thank you for your support and I am looking forward to your child's successful year in math.

Sincerely,

I have reviewed this letter with my child.

Parent Signature ____

Activity

Computer Gradebook for Reports to Parents

Objective	To give students and their parents updated progress reports of their grades in math
Grade Level	Grades 1–6
Time	Less than one hour to set up, 20 minutes per week to enter scores (Once set up, the benefits of this activity outweigh the time it takes initially.)
Materials	Computer, printer, and gradebook program
Procedure	Select a gradebook software program that will run on your computer, and follow the instructions to set up printouts of student scores and grades, as well as personal messages to students or parents. For parent reports, write comments about student progress, and ask students to obtain a parent's signature. You can send these progress reports to parents two or three times during each grading period. Some teachers offer extra credit to students for parent signatures. Some suggestions for comments to parents are presented on the following pages, which include examples of printouts from the *Gradebook Plus (Pro Version)* program.
Variation	Reports can be personalized for students, with comments about their progress and positive suggestions for improvement. Make sure that your comments stress your belief that the student has the ability to learn math.

The following list includes a sampling of gradebook computer programs:

Gradebook Plus (Pro Version) (Apple II)
E.M.A. Inc.
P.O. Box 339
Los Altos, CA 94023

Apple Grade Book (Apple II)
Gradebook Delux (Apple II)
Gradebook Average Reporter (TRS 80) (Commodore 64/128)
Learning Arts
P.O. Box 179
Wichita, KS 67021

TO: ______________________________ FROM: Ms. Jones

Here is a progress report on your daughter's math work. She will be given five extra credit points if this is returned with your signature on it by Friday.

Gina Jefferson's scores as of 10/5/89

1. Homework Sept. 15: 4/5
2. Decimals page 36: 4/5
3. Adding Decimals page 40: 4/5
4. Estimating Decimals page 44: 5/5
5. Homework Sept. 25: 4/5
6. Quiz—Decimals: 9/10
7. Homework Sept. 28: 5/5
8. Subtracting Decimals: 3/3
9. Using Data from Map: 7/8
10. Homework Oct. 1: 4/5
11. Quiz—Adding Decimals: 7/10

Total Possible Points: 56/66 84.8% = B

Parent's Signature ____

TO: ______________________________ FROM: Mr. Smith

I am pleased to report that since our telephone conference, Jennifer's math achievement has improved; your support has made the difference. Jennifer has brought her failing grade up to a passing grade. With three more weeks in this grading period, I am hoping to see even more improvement.

Jennifer Jackson's scores as of 10/15/89

1. Homework Sept. 15: 3/5
2. Decimals page 36: 3/5
3. Adding Decimals page 40: 2/5
4. Estimating Decimals page 44: 0/5
5. Homework Sept. 25: 4/5
6. Quiz—Decimals: 8/10
7. Homework Sept. 28: 3/5
8. Subtracting Decimals: 3/3
9. Using Data from Map: 6/8
10. Homework Oct. 1: 4/5
11. Quiz—Adding Decimals: 7/10

Total Possible Points: 43/66 65.2% = D

TO: ______________________________ FROM: Ms. Russell

Here is a progress report on your daughter's fifth grade math work for the last grading period. Although Mary Ann is currently passing, her grade has recently fallen from a C to a D, and she appears to be having difficulty with decimals. I have some suggestions for supplementary activities that you can do with Mary Ann at home to strengthen her decimal skills. Please call me at xxx-yyyy, so that we can discuss this matter.

Mary Ann Bourne's scores as of 10/15/89

1. Homework Sept. 15: 3/5
2. Decimals page 36: 3/5
3. Adding Decimals page 40: 2/5
4. Estimating Decimals page 44: 3/5
5. Homework Sept. 25: 3/5
6. Quiz—Decimals: 6/10
7. Homework Sept 28: 3/5
8. Subtracting Decimals: 2/3
9. Using Data from Map: 6/8
10. Homework Oct. 1: 3/5
11. Quiz—Adding Decimals: 6/10

Total Possible Point: 40/66 60.6% = D

Activity

Telephone Calls to Each Parent

Objective To establish personal communication with parents to obtain their support and involvement in the educational process

Grade Level Grades 1–6

Time 5 minutes per student once or twice per year, for a total of approximately three hours

Materials Telephone and positive comments about each student

Procedure Set aside three one-hour periods in the evenings or on weekends to make a personal call to each parent. You might begin by saying, "Hello, this is Ms. Rey. I am your daughter's math teacher. May I have five minutes of your time to explain our math program?" Continue by explaining that working with the parent helps their child suceed in math.

Topics you may want to cover briefly include:

1. You are pleased to have their child in your math class.
2. You have a goal that their child grow one or more academic years in math.
3. Explain homework, testing procedures, and the need for parents to set up a quiet place to study at a prescheduled time daily.
4. Explain grading procedures.
5. Explain standardized or criterion testing that is done yearly in your school system.
6. Let parents know when you are available for conferences and how to make appointments.
7. Ask parents to make positive comments to their child about math. Particularly stress the need to be supportive and encouraging, but to let the student do his or her own work. Close by inviting parents into the classroom during a math lesson at a prescheduled time.

If parents ask for general information about helping their child, suggest some of the resources listed at the end of this section, such as *Family math* by Stenmark et al. You may also want to ask if parents notice that their child is having a problem with some specific math skill. If so, offer suggestions to help (see strategies in this section).

If you feel some parents may not like being called at home, you might want to send a note home announcing that you will be calling.

Variation You may elect to call just the parents who missed open house.

Activity

Open House

Objective	To involve parents in their children's math education
Grade Level	Grades 1–6
Time	Variable
Materials	"Tips for Parents of Girls" handout on the following pages
Procedure	In addition to your usual presentation at the school's open house, give copies of one or more "Tips for Parents" sheets to the parents of girls. Encourage the parents of boys to take the sheets also.
Variations	1. Starting with these handouts, prepare others and mail them to parents throughout the school year. Or, use the information to create articles for the school newsletter. 2. Modify and develop for parents of boys.

Handout

Tips for Parents of Girls

Build Positive Attitudes toward Mathematics

Girls respond more than boys to parents' expectations and aspirations for them—have high expectations for her.

Math can be a difficult subject, but it's no more difficult for girls than for boys—be sure you don't give the impression it is.

Get across the message that all students—both boys and girls—have to practice to develop their math skills.

Let your daughter know you think she has the ability to learn math concepts and skills. Never indicate that you feel she is incapable.

Encourage her to do well in math and to expend effort; praise her for her learning accomplishments, but not just for "trying."

To develop her confidence, make sure she practices math skills. Let her know that persistence is a big part of math success.

Recognize her abilities, and show her you have confidence in her. Take an active interest in her education.

Let her know that you believe math is just as important for girls as for boys.

Whenever possible, help her see how math can be used at home—for example, counting the number of place settings needed for dinner, dividing a pie, or deciding which items to purchase.

Communicate to her that girls can do anything, and that she can have any career she chooses.

Foster Sound Mathematics Learning Strategies

If your daughter becomes frustrated and feels she just can't do math, don't give in to her tears. Be calm and supportive, while encouraging her to work through the problem.

When she's experiencing difficulty, ask questions that focus on what she does know about the problem; don't give her the answer or tell her how to solve the problem.

Try to help set goals that focus on understanding math and learning to apply the concepts, not just on getting a particular grade or test score.

Encourage your daughter to be independent; help her feel good about taking intellectual risks. Let her know it's okay to fail, and that we learn from our mistakes.

Help her practice estimating and then measuring or counting to check out her estimations; e.g., how wide is the TV screen, which is farther—the grocery store or the movie theater, how many flowers are there in the garden, etc.

Make sure that math practice at home has a problem solving orientation. For example, "If you need to get to school by 8:15 A.M., and it takes 25 minutes to get there, when do you need to leave?" Let her practice her math skills on all sorts of "around-the-house" problems.

Encourage her to use objects, or manipulatives to reason out problems and to learn basic skills. For example, use marbles, buttons, blocks, etc. to help your child see how division works.

Encourage her to draw diagrams of math problems. Drawing a picture often helps give meaning to the problem's words and helps the student "see" a solution.

Toys, Games, and Computers

If possible, provide a calculator, and help your daughter explore its many and varied uses.

If possible, give your daughter access to a computer, and help her learn to use it.

Find software games that teach math concepts and are fun and interesting for girls. (Ask her math teacher for a list of possibilities.)

Encourage her to play with blocks, erector sets, and other "masculine" toys that teach spatial relationships. Don't label toys as being "for boys" or "for girls," but "for children."

Find books of math puzzles and games; use them to help her learn math concepts and practice skills in an intersting and pleasurable way.

Play games with her. For example, the game, Master Mind can strengthen logical-thinking and problem-solving skills. Jigsaw puzzles can help with shape recognition and memory.

Provide Role Models

Become a role model for your daughter. Show by your actions that you enjoy and are competent using mathematics. Avoid telling her you are "no good" at math, no matter how you actually estimate your own skills.

Whenever possible, both parents need to model diverse roles, so that their daughter will see males and females doing nontraditional activities; for example, father fixing dinner or taking care of the baby; mother repairing a broken appliance, balancing the checkbook, or mowing the lawn.

Use books and stories to introduce women in mathematics and science.

Discuss women's traditional and nontraditional roles as depicted on TV. Help your daughter learn that each person is unique, and that she does not need to follow a traditional path in planning her future.

Provide magazines that show women in math-related careers.

Resources

Burns, M. 1982. *Math for smarty pants.* Boston: Little, Brown.

This book contains a wide range of accessible activities presented in an entertaining format. It would be particularly useful for expanding upper elementary students' perceptions of mathematics.

Burns, M. 1975. *The I hate mathematics book.* Boston: Little, Brown.

For those students who "seemingly" hate mathematics, this book provides many relevant activities to boost confidence and aspirations. Positive attitudes toward mathematics develop as students experiment with and investigate the uses of mathematics in solving everyday problems. Suitable only for upper elementary students.

Jensen, R., and Spector, D. 1984. *Teaching mathematics to young children.* Englewood Cliffs, NJ: Prentice-Hall.

This teacher and parent resource suggests many activities that can be used to explore math concepts with young children. The suggested vehicles for math instruction—including manipulative and creative movements, art activities, and games—allow children to tackle new ideas while developing problem-solving skills. Chapters and activities are organized from concrete to abstract, so that young children may master mathematical concepts and gain confidence in learning.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. Ultimately, the purpose of the program is to help teachers promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes activities that increase girls' confidence in math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction. Materials are suitable for grades 4–12.

Kreinberg, N., and Stenmark, J. 1984. "Debunking the girls-can't-do-math myth." *Family Learning* 1, no. 3: 94–95.

This one-page article could be used as a handout for parent conferences. Especially written for parents, the paper stresses the importance of math education for girls and gives specific suggestions on how parents can encourage their daughters to achieve in mathematics.

National Institute of Education. n.d. *Help your child learn math.* Reston, VA: National Council of Teachers of Mathematics.

This excellent brochure stresses to parents of students, grades K–4, how they can reinforce essential math skills in counting, estimation, and identification and correction of mistakes.

Reys, B. 1982. *Elementary school mathematics: What parents should know about estimation.* Reston, VA: National Council of Teachers of Mathematics.

This book explains the importance of estimating skills by using real-life situations and provides techniques and hints for teaching the skills to children.

Reys, B. 1982. *Elementary school mathematics: What parents should know about problem solving.* Reston, VA: National Council of Teachers of Mathematics.

This book is full of specific problem-solving techniques as well as ideas for real-life experiences that can help children integrate classroom mathematics with their worlds.

Scott-Jones, D., and Peebles-Wilkins, W. 1986. "Sex equity in parenting and parent education." *Theory into Practice* 25, no. 4: 235–42.

This article is from an issue devoted entirely to the topic of sex equity and education. It is an excellent resource for information about parents' role in the process of sex-role stereotyping. It provides excellent background reading for teachers and counselors who will be working with parents to promote math for girls.

Skolnick, J.; Langbort, C.; and Day, L. 1982. *How to encourage girls in math and science: Strategies for parents and educators.* Palo Alto, CA: Dale Seymour Publications.

This excellent resource examines the effect of sex-role socialization on girls' math/science skills and confidence. It explains how attitudes, parenting and teaching practices, stereotypical play activities and books, peer pressure, and career and family expectations cause girls to question their abilities in math and science, and thus hinder their development in these areas.

In addition to the summary of the socialization process, the book contains a variety of compensatory educational strategies and activities that may be used to encourage females in mathematics. These particularly focus on increasing math confidence, spatial visualization skills, and problem solving. Both parents and educators can benefit from this book.

Smith, S., and Backman, C., eds. 1975. *Games and puzzles for elementary and middle school mathematics: Readings from the* Arithmetic Teacher. Reston, VA: National Council of Teachers of Mathematics.

This book contains more than 100 articles on the use of games and puzzles to capture student interest and imagination.

Stenmark, J. K.; Thompson, V.; and Cossey, R. 1986. *Family math.* Berkeley: University of California, Lawrence Hall of Science.

If mathematics promotion is a goal of your teaching, *Family math* activities will help you introduce parents and children to ideas that improve their math skills and help them gain an appreciation for math. Hands-on mathematical experiences provide families an opportunity to develop problem-solving skills by using the following strategies: looking for patterns, drawing pictures, working backwards, working cooperatively with a partner, and eliminating possibilities. Spatial relationships (geometry), estimation, data interpretation (probability and statistics), and mathematical reasoning are the mathematical concepts learned from *Family math.* Materials suitable for ages 5–18.

Working with School Counselors

If your district has elementary school counselors, they can be valuable allies to assist you in presenting information on math-related careers to students and in encouraging girls to continue math studies and consider math-related careers. However, counselors at the elementary level typically don't have access to the students on a regular basis. Often, they need to be invited into your classroom. Before doing this, it is important that you determine your school counselor's attitudes toward girls and mathematics. Many counselors hold stereotyped views about appropriate occupations for women and about females' math abilities. Out of "concern," many counselors steer girls away from math—believing it is "too difficult" or "not appropriate" for them.

- Counselors provide boys more explicit rewards, encouragement, and reinforcement for learning mathematics and for considering math-related careers than they do for girls. In one study, counselors admitted they had discouraged girls from taking advanced math classes because of their own stereotyped attitudes toward women and math. (Stage et al. 1985)
- Counselors appear to have either a neutral or a negative effect on girls who want to pursue math-related careers. (Armstrong 1980)
- Several studies of women who pursued mathematics study and careers indicate that counselors often provided no encouragement—some even attempted to discourage girls from pursing mathematical or scientific careers. Counselor encouragement was significantly related to advanced mathematics course enrollment of twelfth grade boys, but not girls. (Fox 1981)
- Casserly found that many guidance counselors still believe that careers in mathematics are more appropriate for males. (Cited in Fox 1981)

The strategies on the following pages will give you some suggestions for ways you can both subtly educate and enlist the help of counselors in your efforts to increase all students' awareness of math usefulness and math-related careers.

Strategies

1. Establish a link with your school counselor; try to make her or him your ally in encouraging girls in math. If your school counselor is too busy with emotional and abuse problems, try to enlist the help of a middle or high school counselor from one of the schools yours feeds into.

2. Talk with your school counselor about girls and math on an informal basis. Try to determine your counselor's attitudes. If you find your counselor holds stereotypical views on women and math, try to debunk these myths in a nonconfrontational way. Counselors often have not been exposed to a great deal of mathematics during their education. Let them know how important it is that girls feel confident about math, learn about its usefulness for them and their futures, and avoid stereotyping math as a "male" subject.

3. Provide your counselor with some good reading materials on girls and math. For example, the first three chapters of *How to encourage girls in math and science* by Skolnick et al. contain an excellent summary of the issues involved. Check the resources list at the end of this section for more suggested readings.

4. If your counselor does not already have some good information on math and careers, suggest some sources. Again, check the resource list in the section on math-related careers. Although the two posters *When are we ever gonna have to use this?* by Saunders and *Dropping math? Say goodbye to 82 jobs* by Wiggan are probably too advanced for all but fifth or sixth graders, they are excellent ways to provide counselors with information about the importance of mathematics.

5. Enlist your counselor's help in building a library containing math-related career information for students.

6. Ask the counselor to visit your class and present lessons on stereotyping or on math and careers. The resource list contains some excellent materials with suggested awareness activities suitable for all grades. Also, you might ask your counselor to co-teach lessons on stereotyping with you.

7. Enlist the counselor's support in identifying sites for math occupations-related field trips and/or positive female role models who can visit your classes to talk about their math-related careers.

8. Ask your counselor to help you involve parents in encouraging their daughters in math. Ask him or her to assist in developing activities for parents, writing a column about girls and math for your school newsletter, or speaking to parent groups.

Resources

Askew, J. 1982. *The sky's the limit in math-related careers.* Newton MA: Women's Educational Equity Act Publishing Center/EDC.

This interesting book describes contemporary women in highly math-related occupations. Each of the chapters—computers, engineering, finance, math education, research mathematics, and statistics—includes several pictures and quotes from women about their jobs and the satisfaction they receive from them. Content is suitable for upper elementary students.

Casserly, P. L. 1983. "Encouraging young women to persist and achieve in mathematics." *Children Today* 12, no. 1: 8–12.

Casserly's article summarizes the factors that enhance or inhibit young females in their study of mathematics. Many strategies for elementary classrooms, counselors, and parents are discussed.

Kaseberg, A.; Kreinberg, N.; and Downie, D. 1980. *Use EQUALS to promote the participation of women in mathematics.* Berkeley: University of California, Math/Science Network.

This handbook assists educators in conducting teacher training to increase awareness of the problem of female math avoidance, enhance female interest and competence in mathematics, and provide information about opportunities for women in nontraditional careers. Ultimately, the purpose of the program is to help teachers to promote positive math attitudes and bring about changes in the occupational patterns of women. The book includes activities that increase girls' confidence in their math abilities and relate the usefulness of mathematics to future career choices. An excellent sampling of strategy games, spatial activities, and logic problems is also included, as well as bibliographies on problem solving in mathematics and sex-fair counseling and instruction. Materials are suitable for grades 4–12.

Massialas, B. 1983. *Fair play: Developing self-concept and decision-making skills in the middle school: Decisions about mathematics* (Student guide). Newton, MA: Women's Educational Equity Act Publishing Center/EDC.

Decisions about mathematics includes many real-life activities to interest middle school students and to promote math-related careers. Activities are organized around the topics of "math and money," "collecting and analyzing data," and "your future."

Sargent, A. G., ed. 1985. *Beyond sex roles.* 2d ed. St. Paul, MN: West.

Exercises and information in this book may be used by individual readers or groups to become aware of the sources, scope, and magnitude of female/male sex roles. Although many of the activities require modifications to be suitable for grades K–6, the book contains an excellent discussion of the ways sex roles are learned and reinforced by society. The chapter by Russo on the sex-role socialization process provides particularly good background information.

Saunders, H. 1981. *When are we ever gonna have to use this?* Chart. Palo Alto, CA: Dale Seymour Publications.

If you want a quick answer for the students' proverbial question "When are we ever gonna have to use this?", order this attractively done wall poster. The chart gives students information on just which careers require knowledge of specific math concepts. The chart can also be useful for developing your own math-in-careers activities.

Saunders, H. 1980. "When are we ever gonna have to use this? *Mathematics Teacher* 73, no. 1: 7–16.

An interesting article relating Saunders's findings on use of specific math processes an concepts in 100 different occupations. The article also contains a selection of word problems based on the occupational uses of math. Although many of the problems are too difficult for elementary students, they can provide ideas for developing your own occupation-related problems.

Scott-Jones, D., and Peebles-Wilkins, W. 1986. "Sex equity in parenting and parent education." *Theory into Practice* 25, no. 4: 235–42.

This article is from an issue devoted entirely to the topic of sex equity and education. It is an excellent resource for information about parents' role in the process of sex-role stereotyping. It provides excellent background reading for teachers and counselors who will be working with parents to promote math for girls.

Skolnick, J.; Langbort, C.; and Day, L. 1982. *How to encourage girls in math and science: Strategies for parents and educators.* Palo Alto, CA: Dale Seymour Publications.

This excellent resource examines the effect of sex-role socialization on girls' math/science skills and confidence. It explains how attitudes, parenting and teaching practices, stereotypical play activities and books, peer pressure, and career and family expectations cause girls to question their abilities in math and science, and thus hinder their development in these areas.

In addition to the summary of the socialization process, the book contains a variety of compensatory educational strategies and activities that may be used to encourage females in mathematics. These particularly focus on increasing math confidence, spatial visualization skills, and problem solving. Both parents and educators can benefit from this book.

Wiggan, L., ed. n.d. *Dropping math? Say goodbye to 82 jobs.* Chart. Canada: Toronto Board of Education, Mathematics Department.

A brightly colored 18" x 24" poster that displays, in graphic form, each level (in the Canadian school system) of mathematics required for 82 jobs. You can easily relate the levels to those in the United States. The poster is suitable for students in grades 5–12.

Working with Administrators and Other Teachers to Promote Math in Your School

A school administrator's views on the relative importance of mathematics for students can help or hinder you in promoting math as an interesting and worthwhile subject. Although reading is also an extremely important subject, the recent emphasis on reading across the curriculum has sometimes resulted in the de-emphasis of mathematics. It is important that you work with your school administrators to give mathematics a "high profile" and to provide recognition for students who are high achievers or who have demonstrated strong gains in math achievement.

- Schools can affect mathematics course enrollment and achievement through availability of math courses and programs. (Chipman and Wilson 1985)
- Early identification of mathematically able students and academic tracking are among the most favorable school conditions for female students' later enrollment in advanced math classes. (Casserly, cited in Chipman and Wilson 1985)
- Girls in schools with accelerated science programs showed unexpected gains in math achievement. (Casserly, cited in Chipman and Wilson 1985)

Although academic tracking has been found to be a favorable condition for female students enrolled in advanced math classes, it is important to note that tracking may be detrimental for many students. Students are sometimes tracked into homogeneous "below average" or low-achievement groups based on their standardized test scores. In some school systems, this tracking becomes an almost permanent placement that restricts students from advancing to higher level math courses. Because they have not had the background in earlier years, these students find themselves unable to enter academic college prep math classes in high school. The ideal school situation is one in which each student is challenged at his/her own level of ability, and each is allowed to reach her/his maximum achievement in all subjects.

The following strategies can be used to enlist administrator support, work with other teachers, provide personal recognition for math students, and generally promote mathematics in your school.

Strategies

1. Your principal can set the tone for promoting math in your school and can act as an advocate for teachers. Enlist your principal's support in promoting mathematics, especially for girls.

2. Make sure your principal understands how important learning computer programming is to your students' futures. Lobby for a modern computer lab with up-to-date equipment and software.

3. Ask your principal to provide personal recognition to students who have made outstanding progress in math (see activities on the following pages).

4. Your principal may have developed excellent ties with people in business and industry. Enlist their aid in selecting and contacting outside speakers who can serve as role models for girls in math.

5. Often elementary teachers need time to develop their math-teaching skills; e.g., learning to incorporate manipulatives, and so forth. Urge your principal to make staff development activities in mathematics a priority for teaching in your school and to provide adequate release time for teachers who wish to participate.

6. For girls with high math ability, early identification, homogeneous grouping, and accelerated math programs have been found to be extremely positive factors in promoting later math study and careers. The earlier the acceleration is accomplished in elementary school, the better, according to Casserly (1983). Enlist your principal in efforts to design an accelerated math program for those students who are unchallenged by the regular mixed-ability classroom.

7. As suggested with counselors, talk with other teachers and administrators in a nonthreatening way about girls and math. Try to help them understand the importance of teacher expectations and interaction patterns as well as math confidence-building for girls. Make sure they're aware of how important math is for girls' futures, so that they don't "let them off the hook" when it comes to learning mathematics.

8. Form a math promotion team of teachers, counselors, and administrators in your school. Get together to brainstorm ideas on how you can build a positive school climate for mathematics and how you can provide recognition and rewards for students' accomplishments in mathematics.

9. Help other teachers strengthen the math curriculum in your elementary school by incorporating a problem-solving approach to math. Make sure they don't ignore teaching word problems.

10. Ask one or more other teachers to participate with you in the exercises to assess teacher-student interaction patterns described in the "Learning Environment" section of this guide.

11. Suggest that other teachers also conduct stereotype awareness activities with your school counselor in their classes.

12. Enlist other teachers to help you carry out a research project to determine whether students in your school hold stereotypical views about appropriate careers and roles for women. The resource list following these strategies contains references with activities that will help you do this.

13. Work with other teachers to develop ways you can incorporate mathematics into other subjects; for example, using math-related activities in history class, assigning readings about women mathematicians, having students write about mathematics, using math in science projects, and so forth. These activities will help students see how mathematics relates to and can be used in almost every other school subject. Check the resource list for curriculum guides and programs that integrate math into science and language arts.

14. Use your math team to monitor students' progress as they move from teacher to teacher through the elementary grades.

15. If other elementary teachers feel uncomfortable with math, help organize nonthreatening peer teacher sessions where they can practice and develop their own math skills in a supportive, nonjudgmental environment.

16. Help your school librarian build a collection of mathematics materials. This could include books about women and mathematics, integrating math across the curriculum, games and puzzles, and materials about math-related careers. Check the resource list for suggestions.

17. To provide personal reporting of students' math accomplishments, select a schoolwide "Math Student of the Month" or honor an outstanding math student from each grade. Ask teachers to submit the names of one or two students who have shown outstanding performance or improvement in math. Use a committee of three—an administrator, counselor, and teacher—to select the best of the candidates based on teacher recommendations. Take a photo of the student(s) and place it on the school's main bulletin board. State that "Susan Kelly Is the Math Student of the Month." Issue certificates of merit to the winner and the runners-up.

18. Place a problem of the month on the bulletin board, and let students provide solutions. As much as possible, use problems that allow more than one solution. Encourage students to include diagrams with their problem-solving strategies.

19. Use school newsletters to provide information on outstanding math students, math club activities, math-related guest speakers, or math field trips.

20. Inform the editors of your school district publications about math news or math club activities in your school.

21. At the end of the school year when students are recognized for accomplishments at awards assemblies, make sure that math is not forgotten.

Activity

Letters from the Principal

Objective	To involve adminstrators in the promotion of mathematics; to provide a special opportunity for parents to have their children recognized by educators in a simple, yet important manner
Grade Level	Grades 1–6
Time	30–60 minutes
Materials	Positive comments about students' math performance
Procedure	Personal communications from the school to parents and students help promote a positive, caring image of our schools. Ask your principal to write letters (see examples on the following page) and personally give them to students who complete a given grading period with grades in the top five (or whatever number you select) of their math class. Often the principal does not have an opportunity to meet students and commend them for their success in mathematics. Students should take these letters home. Parents can also use this as an opportunity to encourage their children.
Variation	Ask your principal to write letters and personally give them to students who have improved significantly in your math class. This might include any student who was previously failing and who is now passing, or one whose math grade has risen at least one grade point. These letters should be typed on the school's finest letterhead and copies placed in the students' files.

November 19, 19XX

Dear Ms. Roberts:

Tami's math teacher, Ms. Jones, tells me that Tami ranked in the top five of her math class for the first grading period. I'm sure you must be as proud of Tami as we are. Ms. Jones joins me in congratulating Tami on this achievement, and we urge her to keep up the good work.

Sincerely,

John R. Russell, Ed.D.
Principal

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24 April 19XX

Dear Mr. Green:

Kathleen's math teacher, Ms. Smith, tells me that Kathleen has improved tremendously this year. Her attendance is a lot better, and her classwork and class participation have enabled her to raise her grades to As and Bs. She has been a real contributor to the class.

I join Ms. Smith in congratulating Kathleen and encouraging her to keep up the good work.

Sincerely,

Mary R. Lewis, Ed.D.
Principal

Activity

Principal-Student Conversations

Objective	To provide students with a feeling of accomplishment by having the principal personally acknowledge their math performance
Grade Level	Grades 1–6
Time	Variable
Procedure	Ask your principal to talk to students who are performing on a praiseworthy level in your math class or are showing significant improvement. Ask your principal to encourage these students and to relate the importance of mathematics to success in life, especially for girls.
Variation	Send a group of students to visit the principal to explain a completed math project. The project could include a class survey, graph, probability experiment, set of student-constructed problems, etc. Let students take turns explaining parts of the project.

Resources

Casserly, P. L. 1983. "Encouraging young women to persist and achieve in mathematics." *Children Today* 12, no. 1: 8–12.

Casserly's article summarizes the factors that enhance or inhibit young females in their study of mathematics. Many strategies for elementary classrooms, counselors, and parents are discussed.

Cheek, H. N., ed. 1984. *Handbook for conducting equity activities in mathematics education.* Reston, VA: National Council of Teachers of Mathematics.

In this handbook, the problem of underrepresentation of females and minority group members are discussed, and several programs designed to promote equity are described. The book also includes a comprehensive list of publications, materials, and organizations that can serve as resources.

Coombs, B.; Harcort, L.; Travis, J.; and Wannamaker, N. 1987. *Explorations.* Menlo Park, CA: Addison-Wesley.

A mathematics program based on learning through the use of manipulatives and interacting with the environment. Programs for K–2 and 3–6 integrate math and language arts.

Howard, B. C. 1982. *Mathematics in content areas (MICA): A teacher training approach.* Washington, DC: Office of Education, Teacher Corps.

This resource details an agenda for an in-service program to develop elementary and secondary teachers' mathematical abilities and to help them integrate and teach mathematical concepts across the curriculum.

Tyree, E.; Newman, J.; Motomatsu, N.; Egbers, E.; and Dallas, S. 1983. *Mathematics equity: A resource book.* (Report no. SE 043 564). Washington, DC: National Institute of Education. (ERIC Document Reproduction Service no. ED 237 352)

This publication contains a summary of current research on equity in mathematics education, selected readings, a description of programs for providing equity, and a list of resources.

Wheeler, M. 1986. *Mathematics library: Elementary and junior high school.* Reston, VA: National Council of Teachers of Mathematics.

This is a useful purchasing guide for teachers and librarians. It contains an annotated bibliography of children's math books.

Wiebe, A., and Hillen, J., eds. 1986. *AIMS Newsletter.* Fresno, CA: AIMS Education Foundation.

This newsletter describes the AIMS (Activities that Integrate Math and Science) program. The program includes a wide range of science and math activities and focuses on the integration of learning experiences, problem-solving activities, and cooperative learning.

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Add-Ventures for Girls: Building Math Confidence uses "fun," hands-on activities to expose elementary school girls to the exciting world of math. Building on the latest research, this unique field-tested guide provides the tools teachers need to make math relevant to girls. Through real-world problems and discussions about role models, girls develop realistic expectations for math learning and careers. Activities and information on teacher-student interaction patterns, girls' learning styles, and the importance of parent involvement help teachers create an environment that makes math work for elementary school girls. Companion volume to ***Add-Ventures for Girls*** – junior high.

"A welcome addition to mathematics textbooks. As a supplementary text it far outclasses any previously produced work in this area. . . . The text first educates the teacher on the nature of the problem before giving activities to help solve the problem. . . . Refreshingly gender and culturally unbiased.

"I experimented with a number of the activities on my nine-year-old son, and found him begging for more when I stopped. Math had suddenly become a game . . . a very fun game. What is equally important, especially to a mathematician, is that he could explain the mathematics behind the activities."

– J. Keith Brown, North Carolina School of Science and Math

As assistant director for evaluation at the Mathematics and Science Education Network at the University of North Carolina, Margaret Franklin has directed a number of educational research and development projects on gender differences in mathematics. An education specialist for over ten years, Dr. Franklin earned her Ph.D. in general experimental psychology from Purdue University.

Also available from the Women's Educational Equity Act Publishing Center:

Fair Play: Decisions about Mathematics, Florida State University

A Mindset for Math: Techniques for Identifying and Working with Math-Anxious Girls, Ohio State University

Spatial Encounters: Exercises in Spatial Awareness, University of New Mexico

How High the Sky? How Far the Moon? An Educational Program for Girls and Women in Math and Science, Sharon Menard

Expanding Your Horizons in Science and Mathematics, Mills College

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